VOLUME X—1986

Man
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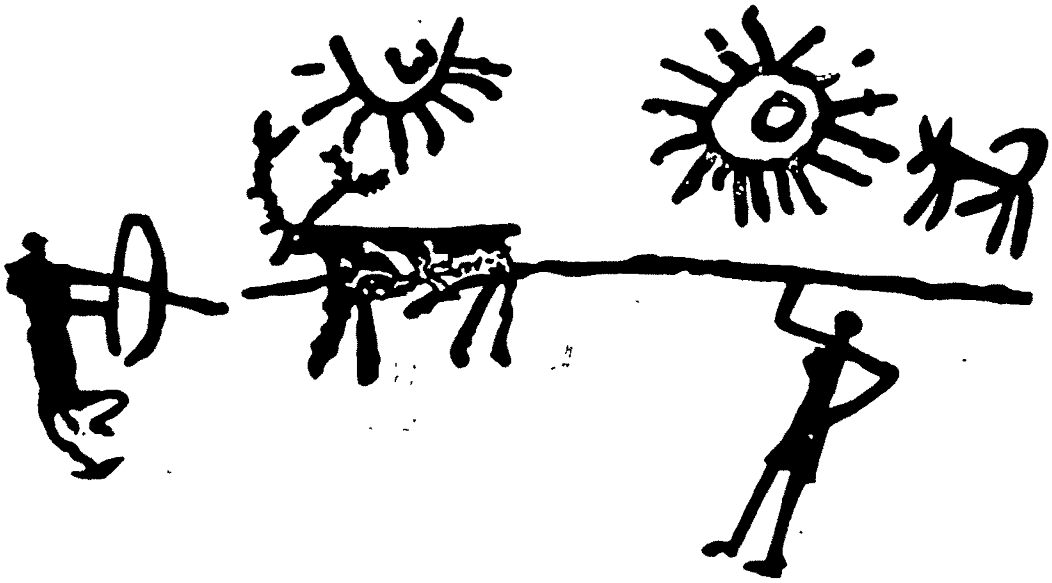

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The journal is distributed by M/S Books and Books, C4A/20 A Janakpuri, Delhi-110 058

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EDITORIAL

This is the 10th issue of *Man and Environment*, and on this occasion we may permit ourselves the luxury of thinking that this journal which even now can be published only once a year has played a role in making archaeology a little more multi-disciplinary and thus a little more academic in this country. The disciplines we expect to contribute significantly to the development of academic archaeology in the country are the entire spectra of sciences which throw light on the past human behaviour and adaptation.

Apart from a couple of national institutions (the Physical Research Laboratory, Ahmedabad and the Birbal Sahni Institute of Palaeobotany, Lucknow), the only university centres with more than a marginal interest in the scientific analysis of archaeological remains are the Deccan College, Pune, and the Department of Archaeology and Ancient History, M.S. University, Baroda. This is a sorry state of affairs and one does not have to be an analyst of the Indian academic scene to realize that in the various university departments of history and ancient history, of which archaeology is often a part, it is viewed essentially as a set of techniques which are expected to provide the departmental historians with raw data. For instance, in the Departmental Council meeting of the Department of History, Delhi University, on 20-4-85 an ancient historian (K.M. Shrimali whose publication on the history of the Panchalas carries a foreword by R.S. Sharma) suggested that the archaeology unit of the department should be under a committee (of historians) with the Head as the convenor. Another ancient historian (D.N. Jha whose Ph. D thesis was supervised by R.S. Sharma) expressed worry about the "chemical" examination of archaeological artifacts in the department. He also found it disturbing that M. Phil dissertations should be done on the material explored by the department's archaeology-museum unit. The fact that one of these historians is a joint secretary of the Indian History Congress and the other one a former sectional president of the same organization seems to provide a commentary on the present academic leadership of this body of historians. What we want to emphasize is that such comments as these may not be isolated incidents. In fact, we would argue that archaeology is under seige from historians in most of our universities. How long this state of affairs will continue depends on the strength with which the archaeologists of this country exert themselves. We hope that *Man and Environment* will always be a forum through which Indian archaeology will consolidate its academic strength.

We thank the ICHR and the Archaeological Survey of India for their continued support.

We mourn the recent demise of Professor Glyn Isaac .

Dilip K Chakrabarti

The publication of this issue is supported by a grant from the ICHR which is not responsible for the opinions expressed by the contributors to the issue.

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Recent Explorations in the Jamnagar District of Saurashtra

Kuldeep K. Bhan
Department of Archaeology and Ancient History,
M.S. University, Baroda-390 002

INTRODUCTION

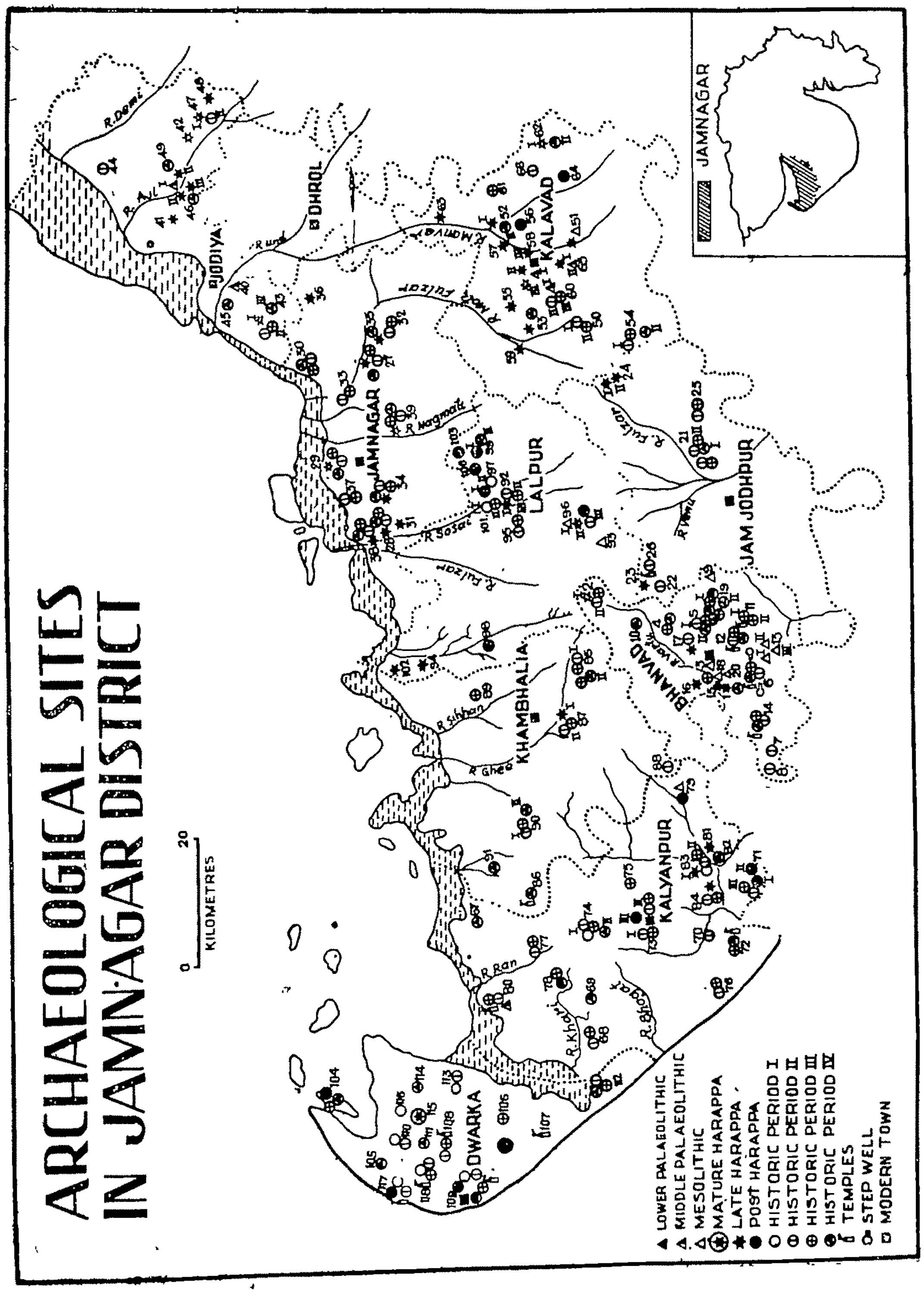
The concept of surface exploration has changed considerably during the past few years. It is now considered to be an important branch of archaeology. A systematic survey of a limited area can provide extremely useful data for building the regional culture sequence, understanding man-land relationships and many other such pertinent information regarding past peoples. Furthermore, the methodological approach to the surface survey and the analysis of craft indicators of a particular site, have the potential to provide relevant interpretations regarding the development of crafts specialisation and social stratification (Bondioli *et. al* 1984 : 9-35). But the full potential of such exploration is rarely exploited. In this paper I propose to show the potential of data obtained from carefully planned explorations of the Jamnagar district and the surface analysis of a mature Harappan industrial site at Nageswar followed by excavation, for understanding the various aspects of cultures which have developed in this district through the ages. It may not however, be possible to discuss the results of the excavations with all the specific inferences drawn during the present investigations. Therefore I shall confine myself to the general results.

The choice of Jamnagar district for intensive exploration was made because of its important geographical location and keeping in mind ecological considerations. This district has a very long coastal belt on its northern and eastern sides (Fig. 1), providing many sheltered ports and a vast quantity of marine resources. The Barda hills situated in the southwest of the district (Bhanvad Taluka) are rich in floral, faunal and lithic resources, these along with the rich black soil of the district, might have played an important role in the development of various cultures in the area. The district might also have had witnessed a multiplicity of cultures, as it lies almost on the way to the people, who travelled from Sind to Gujarat. The above fact was very well attested to by earlier explorations (Pandya 1956 : 1-12), and by excavations conducted in the district at Dwarka (Ansari and Mate 1966), Amra and Lakhabaval (IAR 1955-56 : 7). These discoveries revealed the possibilities of many more discoveries and also provided the basic chronological framework on which the general hypothesis could develop.

Area Surveyed, Topography, Nature of Soil and Drainage

The district under review is situated between 27°47′ and 28°57′ north and 68°57′ and 70°37′ east in the peninsular region of northwest Gujarat known as Kathiawar, the colloquial name for Saurashtra. It measures about 128.70 kms from north to south and about 160.37 kms from east to west. The total area of the district is 10.921 Sq. kms (Patels 1970 : 2). It has been divided into ten talukas for administrative purposes.

Saurashtra forms a distinct ecozone with its semi arid climate, black-cotton soil and long coast line. The district forms a part of the same ecozone. Different


ARCHAEOLOGICAL SITES IN JAMNAGAR DISTRICT
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20
KILOMETRES
JAMNAGAR
JODIYA
DHROL
JAMNAGAR
KALAVAD
LALPUR
JAM JODHPUR
BHANVAD
KHAMBHALIA
KALYANPUR
DWARKA
R. Demi
R. Aji
R. Und
R. Nagmati
R. Sasoi
R. Fulzar
R. Sihhan
R. Ghee
R. Ran
LOWER PALAEOLITHIC
MIDDLE PALAEOLITHIC
MESOLITHIC
MATURE HARAPPA
LATE HARAPPA
POST HARAPPA
HISTORIC PERIOD I
HISTORIC PERIOD II
HISTORIC PERIOD III
HISTORIC PERIOD IV
TEMPLES
STEP WELL
MODERN TOWN

Fig. 1.

talukas vary to some extent in topography and ecology. Jamnagar, Khambaliya and Kalyanpur talukas are partly hilly and partly plain. Dhrol taluka is undulating though without any hills or hillocks. Bhanvad and Jamjodhpur talukas are exceedingly hilly and mountainous with only a 23 cms deep soil cover. Bhanvad taluka still supports a true forest in the Barda hills. Okhamandal taluka is largely an undiversified plain and prevailing features include a few isolated hills and hillocks which crop up here and there.

Soils are generally derived from trap rock and forms a 23 to 93 cms deep cover. The black soil is found along the river banks and though occupying a small area, it is the richest soil in the district. The alkaline soil locally known as *Khar* is found in coastal areas and predominantly in Okhamandal taluka.

Drainage in the Jamnagar area and as a matter of fact in the whole of Saurashtra has a radial pattern, with rivers flowing out from the central high lands in all directions and developing a dentric net work. The rivers are not perennial and flow lazily.

Explorations

An intensive village to village survey was carried out during four field seasons (November-March, 1979-82) in the district. This investigation revealed nearly 118 sites (including 30 sites reported in various numbers of *Indian Archaeology : A Review*). On the basis of distinctive stone tools, pottery, sculptures and temples, the following cultural sequence emerges (refer to fig. 2 also)

Cultural Periods (1)	*Number of Sites* (2)	
(A) *Prehistoric Period*		
Lower Palaeolithic	1	Nil
Middle Palaeolithic	4	1*
Mesolithic	13	2*
(B) *Protohistoric Period*		
Mature Harappan	1	Nil
Late Harappan		
(a) Habitational sites	21	20*
(b) Lithic Factory sites	2	Nil
Post Harappan	16	8*
(C) *Historic Period*		
Historic Period-I	10	2*
Historic Period-II	54	10*
Historic Period-III	33	5*
Historic Period-IV	31	3*

(The asterisk marks indicate the number of known sites before the present investigation was undertaken. However, the increase in the number of sites in the above table is because some of the sites and villages represent more than one cultural period).

A. PREHISTORIC

Lower Palaeolithic

A few tools of rhyolite (Fig. 2) were found loose in the river bed of Vertu near Triveni-Sangam (Bhanvad taluka). The assemblage consists of a handaxe, two scrapers and a cleaver. Our observations are limited since the collection is very small and also because of non availability of *in-situ* tools. However, it is interesting to note that the lithic assemblage shows typo-technological affinities with tools found in pebble conglomerate from the river Bhadar at Rojadi (Sankalia 1974 : 97-99) and the Hiran valley (Marathe 1981 : 91-101).

The present discovery along with other discoveries in the Lower Palaeolithic sites from the Hiran valley, (Marathe 1981 : 161) Sonrakhi (Marathe and Rajaguru 1977 : 133-144) the Kalubhar valley (Chakrabarti 1978) and the Bhadar valley (Sankalia 1974 : 97) in Saurashtra indicates that this was once the home of stone age folk and even small rivers like the Vertu were once inhabited by these nomadic food gathers.

Middle Palaeolithic

The sites of this period were found in the eastern portion of the district only. However, a site has also been discovered in the western portion near Pindara. (J. P. Joshi—personal communication) The present investigator, however, could not locate this site.

The river beds of Und, Aji and Manvar near Anada, Tarana and Kalavad villages revealed the tools of this phase. But none of the tools were found *in stiu.* The makers of these tools utilised a wide variety of crypto-

JAMNAGAR DISTRICT THROUGH THE AGES

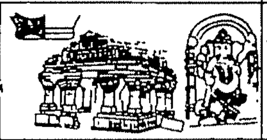
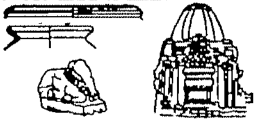
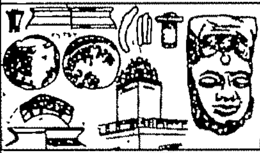
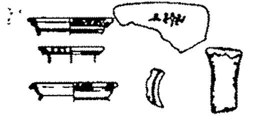
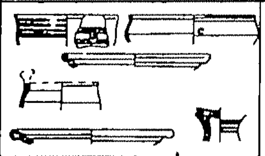
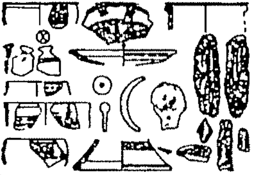
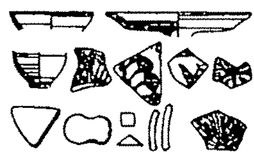
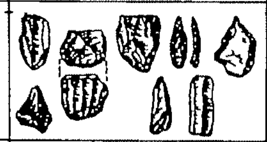
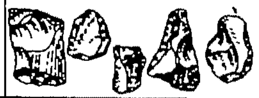
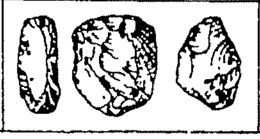
PERIOD		ANTIQUITIES		IMPORTANT SITES	PARALLELS	REMARKS
HISTORIC PERIOD IV	10th CENTURY A.D. TO 13th CENTURY A.D.	GLAZED WARE COARSE RED WARE COARSE BLACK WARE INSCRIPTIONS SCULPTURES STEP-WELLS TEMPLES MINOR ANTIQUITIES		GHUMLI DWARKA VASAI BEYT BAMANASA BHAITYA GANDHAVI RAVAL	DABHOI BARODA NAGARA PATAN	GHUMLI COPPER PLATE INSCRIPTION OF BASKALDEVA BELONG TO THIS PERIOD
HISTORIC PERIOD III	5th CENTURY A.D TO 10th CENTURY A D	BURNISHED RED WARE BURNISHED BLACK WARE SCULPTURES TEMPLES COINS INSCRIPTIONS		KALAVAD SONKANSARI MEVASA DHRASANVEL PASHTAR VERAVAL JUNI-DHERVAD DWARKA NANDANA	VADNAGAR NAGARA TIMBARVA PRABHAS-PATAN PORBANDAR	THE 5th COPPER PLATES OF SAINDHAVA DYNASTY PROVIDE THE DETAILS OF THE HISTORY OF THIS PERIOD
HISTORIC PERIOD II	00 A D TO 5th CENTURY A D	ROMAN AMPHORAE RED POLISHED WARE BLACK ON RED WARE TERRACOTTAS SPINDLE WHORLS CHANK BANGLES COINS SCULPTURES TEMPLES		SAMIYANA CHACHLANA BALAMBA LAMBA KALYANPUR GOP DHRAFA	RANGMAHAL AMARELI SOMNATH NAGARA BARODA VALBHIPUR	THE INSCRIPTIONS OF MULVASAR AND GUNDA BELONG TO THIS PERIOD
HISTORIC PERIOD I	1st-2nd CENTURY BC TO 00 A D	BLACK ON RED WARE INSCRIBED POT SHERD IRON OBJECTS CHANK BANGLES TERRACOTTA STOPPER		DWARKA PINDARA LIMDI	RANGMAHAL VADNAGAR DWARKA RAIRH WAZIRISTAN TAXILA	THE EVIDENCES OF WRITING APPEARS IN THIS PERIOD.
		G	A		P	
POST HARAPPA	1500 TO 1300 B.C.	RED WARE LUSTROUS RED WARE STONE SCRAPERS		DWARKA VERAVAL HARIPUR I PIPARTODA I & II RAJADA	RANGPUR III ORIYO-TIMBO	
LATE HARAPPA	1800 TO 1500 B.C.	RED WARE BUFF WARE GREY WARE BLACK AND RED WARE LUSTROUS RED WARE COPPER OBJECTS SPINDLE WHORLS CHANK BANGLES CRESTED RIDGE CORES BLADES, POINTS, SCRAPERS ETC		LOLAI RASNAL AMRA BALAMDI KALAVAD ARIKHAN TARANA LAKHABAVAL KOTA	LOTHAL B RANGPUR IIB-C ROJADI SOMNATH KANEWAL	THE SETTLEMENT PATTERN OF THIS PERIOD WERE CONDITIONED DUE TO ACCESSIBILITY OF RAW MATERIAL, PORTABLE WATER AND ALLUVIAL OR BLACK SOIL
MATURE HARAPPA	2500 TO 1800 B.C	RED WARE INCISED RED WARE GREY WARE TRIANGULAR T C. CAKES SHELL INLAY PIECES SHELL BANGLES COPPER OBJECTS		NAGESHWAR	MOHEN JO DARO HARAPPA CHANDU DARO SURKOTADA	
MESO-LITHIC	HOLOCENE 5000 TO 2500 B C	CORES POINTS BURINS BORERS SCRAPERS BACKED BLADES PARALLEL SIDED BLADES FLAKES		MORPUR I, II, III TERWAN JAMAH BHANVAD BALAMDI KRISHEN GADA GODAVARI	KUTCH BAGOR CHOPANT-MANDO	THE CONCENTRATION OF THE SITES WERE FOUND AROUND BARDA HILLS AS IT PROVIDED SOME ADVANTAGES IN THE FORM OF RAW MATERIAL AND RICH FLORAL AND FAUNAL DEPOSITS
MIDDLE PALAEO-LITHIC	LATE PLEISTOCENE	CORES POINTS BURINS SCRAPERS		KALAVAD ANDA TARANA	ROJADI JETPUR RAJKOT MAHADEVIYA NEVASA KALEGAON	RIVER AJI, UND AND KALAVADI REVEALED THE EXISTANCE OF THIS CULTURE
LOWER PALAEO-LITHIC	MIDDLE PLEISTOCENE	HANDAXES SCRAPERS CLEAVERS		PINDARA VIJAYPURA	ROJADI CHAMPANER	TOOLS OF THIS PERIOD WERE FOUND LOOSE IN RIVER VERTU

Fig. 2.

crystalline rock like agate, jasper, chalcedony, pitch-stone, rhyolite, rhyolitic glass and other exclusively volcanic material.

The tools are comparatively smaller than the previous group. The predominant tools of this period are few varieties of scrapers, points and burins developed on flakes and flat base nodules (Fig. 2). The required portion of the tool seems to have been flaked in clactonian fashion and bears affinities with tools found from Kutch (Ansari *et. al.* 1973 : 150-167), Rojadi (Sankalia 1974 : 187) and the Hiran valley (Marathe 1981 : 101-107).

Mesolithic

The artifacts of this period were reported from the the Vertu, Jogari, Balamdi and Sosai river valleys. Nearly 15 sites revealed the traces of this culture. Mostly the sites are concentrated in the southern portion of the district near the Barda hills.

The nature of the sites from which the artifacts of this period were recovered varied to some extent. It was observed that the hillocks and river banks providing flat or gently sloping surfaces with a good view of the river and easy access to the shore were selected. A few boulder-like masses of stome at some of the sites (Morpur I, II and III), overlooking the river were found, and these possibly indicate their being used as ambushing places by mesolithic hunters.

A wide variety of fine grained material like chalcedony, agate and jasper were the common raw materials used. Most of the tools of this period are products of pressure or indirect percussion technique. The analysis of lithic assemblage indicate that it was a wasteful process in which about 90% are waste flakes, while the actual tools are hardly about 5%. Most of the sites are rich in microlithic cores and waste flakes, and yield very few finished tools. It was thus quite obvious that such sites represent workshops.

The complete absence of pottery from the sites indicate that the assemblage belongs to the pre-pottery Mesolithic phase. Another interesting feature of these sites is the complete absence of a core preparation technique known as crested guiding ridge, which was extensively utilised during the chalcolithic period. This feature was not possibly found in Mesolithic sites of Gujarat and Rajasthan (Sankalia 1963 ; Misra 1973). Therefore, a special attempt was made during surface sampling of such sites to find this technological feature which could then be used to separate Mesolithic sites from the lithic blade industries of the chalcolithic period, so as to minimise the chances of exploration error.

The microlithic industry of the district is non-geometric in nature The tool kit consists of blades (either retouched or simple), points, burins and awls or borers (Fig 2). Tyo-ptechnologically this industry shows affinities with the tools found from Kutch (Joshi 1977 : 100) and Banaskantha districts (Parikh 1977 : 12-13). Unfortunately none of the sites belonging to the non-geometric microlithic tradition has been dated in western India. Nevertheless, the geometric microlithic sites of Western India provide a time bracket of 5000 to 2000 B.C. on the basis of radio-carbon dates obtained from Bagor (Misra 1973 : 51-110) and Langhnaj (Sankalia 1974 : 251). These sites in Jamnagar may represent the earlier phase of the Mesolithic period, since the non-geometric microliths are supposed to be earlier than the geometric microlithic tradition. This feature can be observed at Chopani-Mando, where the non-geometrical microliths have been found below the geometrical microliths in stratified levels (Sharma 1980 : 191).

A close look at the prehistoric sites of the district reveal that the Lower palaeolithic and majority of Mesolithic sites were concentrated around the Barda hills. Availability of raw material, dense forest cover and abundant game seem to be the main environmental factors responsible for the man-land relationship, while the Middle palaeolithic sites are not found in this region. The availability of raw material in the Aji and the Und rivers and the congenial semi-arid climate might have supported human occupation. A more or less similar pattern of man-land relationship is observed in other parts of Saurashtra (Marathe 1981 : 119) also.

B. PROTOHISTORIC

Harappa Culture

This is the most adequately known period of the district. This fact is attested to by the discovery of as many as 30 new sites, belonging to various phases of this culture, which raises the total number of sites to 57 and testifies to the intensity of the habitation during this period.

The habitational deposits of these sites are generally very thin except at Nageswar, Tarana, Lolai Narmana, Kota and Rasnal, which have habitational deposits of 2 to 1.5m, while the rest of the sites range between 15 cms to a meter. Nageswar, Rasnal, Kota Balamdi are quite extensive suggesting well settled populous habitations. No architectural activities were attested to at any of the sites, except at Nageswar, where extensive rubble foundations were exposed.

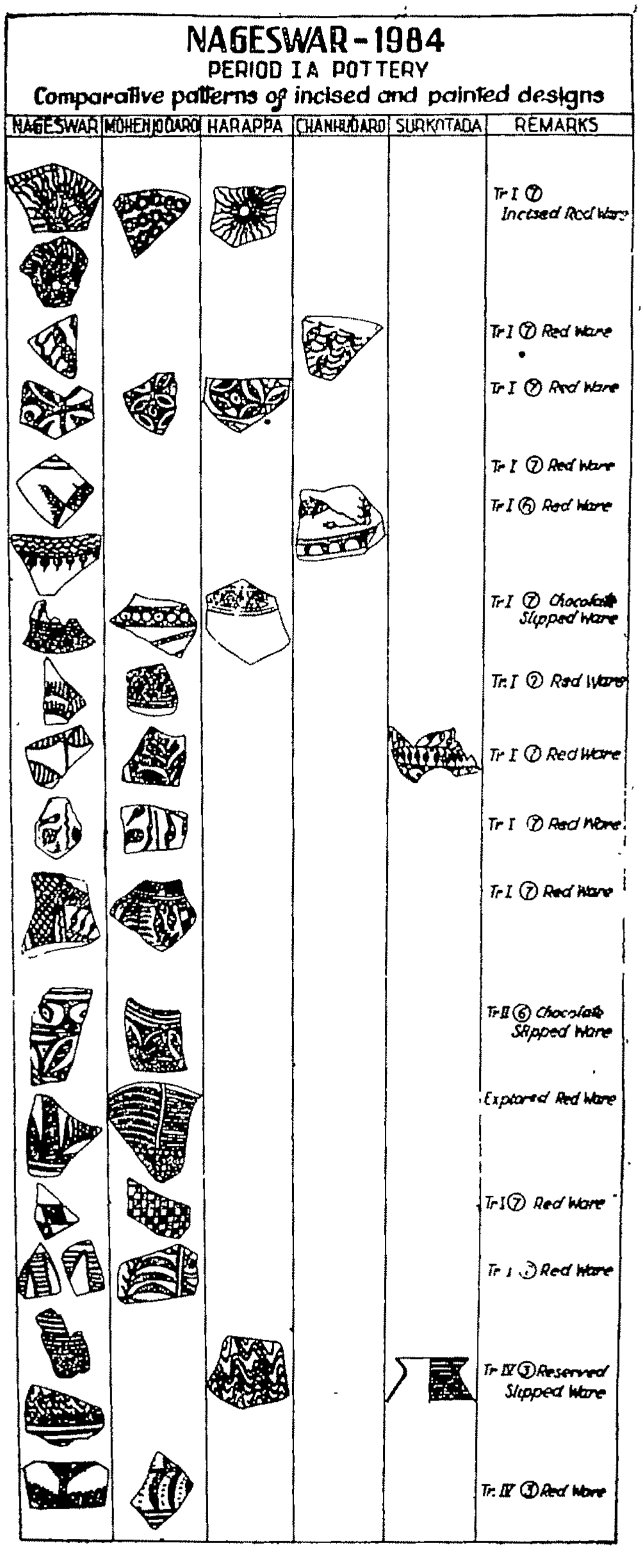
Mature Harappan

It is only from Nageswar that the mature phase of this culture was attested to showing strong typological affinities with the ceramics (Fig. 3) reported from Mohenjodaro, Harappa, Surkotada and Chanhudaro (Hegde *et. al* : 1985). The shell bangles and other antiquities found from this site also represent the same major style found from other mature Harappa culture sites (Bhan 1984a). Moreover, the excavations at the site has confirmed its chronological placement (Hegde *et. al.* 1985.)

The site could be assigned to an industrial function from the evidence of the spread of thousands of fragments of *Turhinella pyrum* linnaeous and *chicorus ramosus* linnaeous gastropod, fragments of shell bangles, ladles and inlay pieces. This is the first site in our country to show such an excellent evidence of an industry based on marine shell. It was therefore considered desirable to undertake an intensive surface survey and excavation. However, as already mentioned above, I do not endeavour to discuss the results of excavation in this paper, which has already been discussed elsewhere (Hegde *et. al.* 1985).

In order to extract information about the possible manufacturing areas, which will help in discerning the craft specialisation and social stratification, the site was put on a grid plan of 10×10 square meters and then each square was carefully explored. The analysis of the surface samples revealed the areas which could be assigned with assurance to the working area of shell.

One such location (Fig. 4) was situated on the south west side of the site, represented by 5c-5cc and 3c-3cc squares of the grid plan. This area was full of a special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Comparative patterns of incised and painted designs
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Tr I ⑦ Red Ware
Tr I ⑦ Red Ware
Tr I ⑥ Red Ware
Tr I ⑦ Chocolate Slipped Ware
Tr I ⑦ Red Ware
Tr I ⑦ Red Ware
Tr I ⑦ Red Ware
Tr I ⑦ Red Ware
Tr II ⑥ Chocolate Slipped Ware
Explored Red Ware
Tr I ⑦ Red Ware
Tr I ③ Red Ware
Tr IV ③ Reserved Slipped Ware
Tr IV ③ Red Ware

Fig. 3.

variety of debris consisting of manufacturing waste obtained during preliminary chipping *T pyrum* and inlay piece production. The eastern side of this area, that is 5aa-5cc and 3aa-3cc squares were covered with a large quantity of tiny chipped fragments of *T pyrum.* This type of waste is produced during the preliminary chipping stages of bangle manufacture, when the apex is perforated and the internal septa is broken loose. The hollowed out shell would then be sawn into rough circlets. The manufacturing waste of the subsequent stages of bangle manufacture was not obtained at this spot. This suggests that the shell sawing location was elsewhere. The location appears to have been used only for the preliminary preparation of shell. The squares 5c to 5a and 3c to 3a appear to be the location for the inlay manufacture. This area yielded large quantities of shell wastes of *T pyrum* and *C ramosus,* variously sawn and chipped and resulting from inlay manufacture.

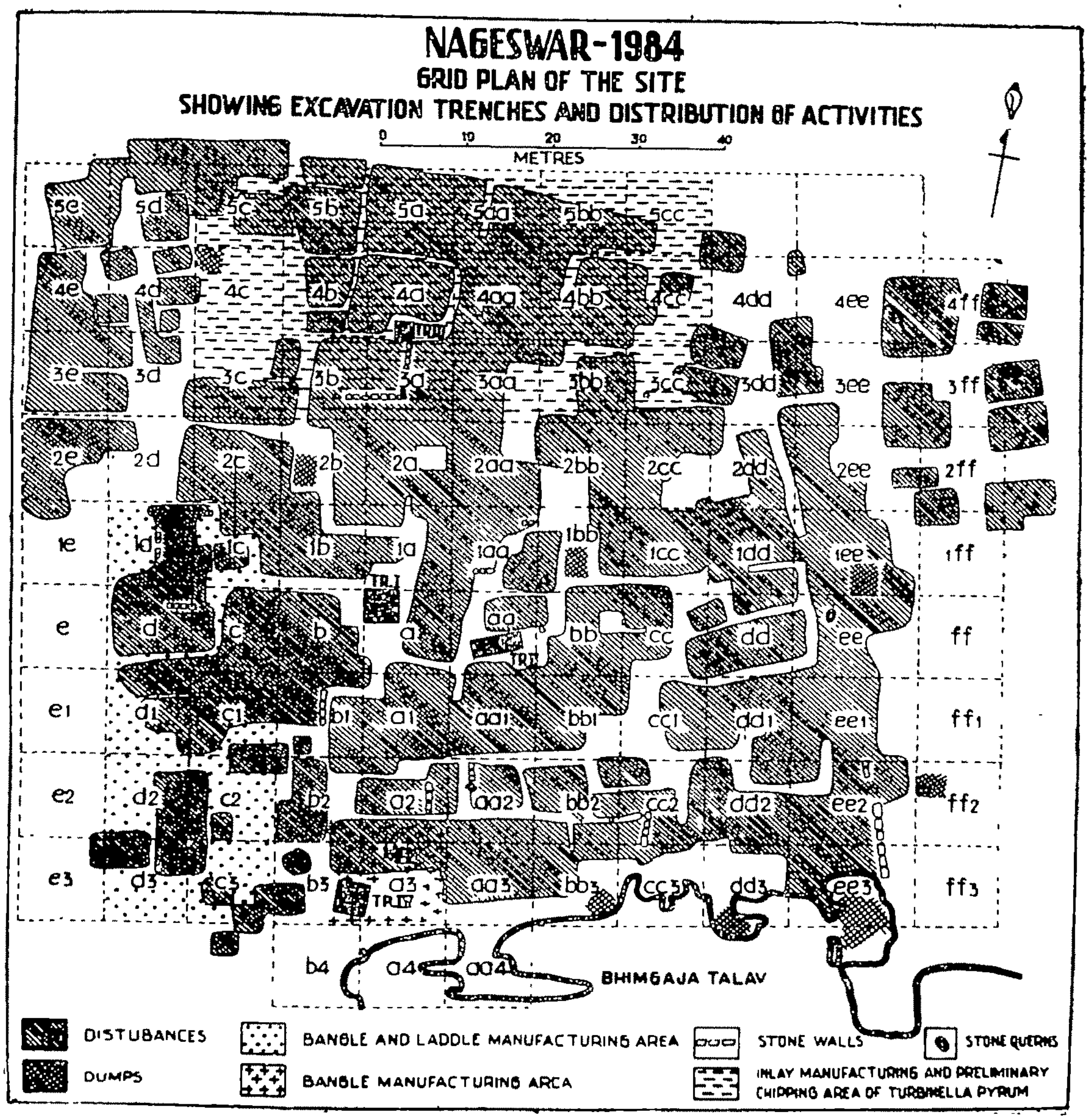
NAGESWAR-1984
GRID PLAN OF THE SITE
SHOWING EXCAVATION TRENCHES AND DISTRIBUTION OF ACTIVITIES
0 10 20 30 40
METRES
5e 5d 5c 5b 5a 5aa 5bb 5cc
4e 4d 4c 4b 4a 4aa 4bb 4cc 4dd 4ee 4ff
3e 3d 3c 3b 3a 3aa 3bb 3cc 3dd 3ee 3ff
2e 2d 2c 2b 2a 2aa 2bb 2cc 2dd 2ee 2ff
1e 1d 1c 1b 1a 1aa 1bb 1cc 1dd 1ee 1ff
e d c b a aa bb cc dd ee ff
e1 d1 c1 b1 a1 aa1 bb1 cc1 dd1 ee1 ff1
e2 d2 c2 b2 a2 aa2 bb2 cc2 dd2 ee2 ff2
e3 d3 c3 b3 a3 aa3 bb3 cc3 dd3 ee3 ff3
b4 a4 aa4
TR I
TR II
TR III
BHIMGAJA TALAV
DISTUBANCES
DUMPS
BANGLE AND LADDLE MANUFACTURING AREA
BANGLE MANUFACTURING ARCA
STONE WALLS
STONE QUERNS
INLAY MANUFACTURING AND PRELIMINARY CHIPPING AREA OF TURBINELLA PYRUM

Fig. 4.

A dump consisting of 714 colleumella, 430 outer margin or lip and 11 apex portions of *T pyrum* were located in a3 and b3 squares occupying an area of 1.30×1 meter (Fig. 4). Such types of fragments are produced during the manufacture of bangles, when the circlets are cut out. Both the lip and the colleumella of *T. pyrum* were used to produce beads, pendants or inlay pieces. Due to the absence of any inlay or bead wastes around the dumps, it appears that the area was a bangle manufacturing location. This neatly kept huge heap was to be taken to an other workshop for reworking.

Another such location (Fig. 4) which could be identified with the manufacture of ladles and bangles from *C. ramosus* was in the 1d-d3 and 1c to c3 squares on the southeast of the site. This area yielded a large quantities of shell wasters of *C. ramosus* and a number of broken ladles. A preliminary analysis of the samples from this area suggest that it might be a manufacturing area for ladles and bangles. The detailed study of the data is not complete yet, this could possibly further substantiate the hypothesis. However, one should bear in mind here that these locations do not indicate precise boundaries, rather they mark generic locations.

It is of interest to note that a somewhat similar pattern of shell distribution activities has been reported from Mohenjodaro (Kenoyer 1984 : 107-108). Moreover, we also have an ethnographic parallel to this type of distribution pattern from the present day bead industry of Khambhat. It appears therefore that the Nageswar shell industry was also based on pattern similar to that of Khambhat where there are different working areas and separate craftsmen for the preliminary chipping, advanced chipping, perforating and polishing stages.

Some of the important features of the surface collection at Nageswar is that it provided a complete range of manufacturing waste, so that it was possible to reconstruct the process of manufacture of bangles and ladles from *T. pyrum* and *C. ramosus* this has been discussed in detail elsewhere (Bhan *et. al* 1981 : 199; and 1984). Besides, the preliminary analysis indicates that the number of finished artifacts are far too few to justify the immense quantities of manufacturing waste. This evidence suggests that Nageswar was primarily a manufacturing centre producing shell objects for trade at nearby and distant Harappa culture sites through the established trade net work. The discovery of Shortugai in Lapis-lazuli region of Badakshan in Afghanistan (Frankfort *et. al.* 1978 : 29-85) and location of numerous Harappan copper and pottery manufacturing sites in Cholistan, Pakistan (Mughal 1980 : 93-98) have provided significant data towards understanding the urban—rural dichotomy and have demonstrated the dependence of major urban centres on the outlying rural resources. Shell is an important material used at most of the Harappa culture sites. Nageswar appears to be one of the important coastal sites which possibly provided raw shell and finished objects to the urban centres situated far inland (Bhan *et. al* 1984 : 89 ; Kenoyer 1984 : 109 : and Hegde *et. al.* 1985).

Another important aspect of Nageswar which became apparent during surface sampling was that the site might have extended further south towards the lake (Fig. 4), where, now there are many dug out pits filled with water. The artifacts recovered from this area, (near cc3, dd3 and ee3 squares) demonstrate typological ties with the stratified artifacts recovered from the 1 A phase (Hegde *et. al.* 1985). However, we could not determine the exact extension of the site on this side of the mound.

Eventhough this analysis of the surface survey is only a preliminary one, it has revealed interesting data and also indicate the potential of additional information latent in the surface data of the site, still awaiting analysis.

Among the other finds, recovered from Nageswar are an agate cubical weight, moulded triangular terracotta cakes, pinched spherical terracotta lumps, terracotta bangle fragments, a terracotta toy cart frame, terracotta spindle whorls and ornamental beads of carnelian, faience steatite, terracotta and hundreds of dentalium shell beads. There are also special querns with small circular depressions, perhaps meant to polish the bangles and cylindrical stone pieces which were probably used for polishing internal cut edges of shell circlets.

Proximity of two Bays (Fig. 1), both rich in *T. Pyrum* and *C ramosus* gastropod, considerations like communication availability of sweet water round the year (Bhan 1984a) in an area where the sub soil water is brackish, margin of fertile soil for agriculture and thick growth of *baru* (*Sorghum halepensis*) in the lake, which might have been used for making small sea going vessels (Bhan *et. al* 1984 : 80) appear to have attracted the immigrant Harappan community to Nageswar.

Late Harappa Culture

Forty two sites of the district revealed the traces of this culture. The ceramic assemblage of these sites shows typological affinities with the pottery reported from the II B-C periods of Rangpur sequence. Prabhas type bowls, bowls with straight and convex sides, dishes with flaring rims and non-carinated shoulders, basins with suspended loop decoration and storage jars with beaded rim are some of the representative ceramic shapes of this phase (Fig. 2).

Moreover, two more sites belonging to this phase were indentified on the basis of chalcedony blades and cores with crested guiding ridge. These sites were completely without any association of pottery and represent factory sites, developed near the lithic resources. However, this type of lithic workshop was also found associated with habitational sites at three different locations.

The dramatic increase in the number of settlements during this phase have been attested elsewhere also. (Possehl 1980). Scholars have argued that the increase in the number of sites is due to the shift in the pattern of landuse from rabi to Kharif crop (Possehl 1974 : 177-78 : Chitalwala 1977 : 95)

Post-Harappa Culture

The ceramic assemblage from fourteen sites yielded a considerable amount of Lustrous Red Ware, showing affinities with the ceramic assemblage of period III of the Rangpur sequence. In this phase large vessels like storage jars were made as before, but the smaller vessels used in daily use show a bright lustrous red surface (Fig. 2). Concave sided bowls, sometimes with handles and dishes with beaded rims are some of the representative shapes of this phase. Oblique wavy lines and hatched diamond decoration, becomes more frequent as a mode of decoration in this phase.

The lithic appendage of this phase witnessed a change, which was now represented by a number of varieties of scrapers, curiously, showing affinities with the scrapers of the Middle Palaeolithic phase. However, it is interesting to note here that such scrapers have also been reported from other post-Harappa culture sites in Saurashtra (Majumdar 1962 : 8).

This phase witnessed a decrease in the number of sites. A similar decrease in period III sites has been attested to by Possehl also during his survey of the Ghelo and the Kalubhar Valleys (Possehl 1980 : 60). Unfortunately, this is the least understood phase of the Harappa culture. Recently an attempt has been made to understand the economic factors contributing to this cultural change. Rissman who excavated a small site known as Oriya Timbo in the Bhavnagar district, has attributed the reduction of settlement count to nomadization (Rissman 1983 : 6). As more survey work is done and when some of the sites belonging to this phase are excavated, we will be able to appreciate more of the socio-economic aspects of this important phase, which witnessed the end of a great culture.

Pattern of settlement in the Jamnagar district during the Harappan period seems to have been basically guided by considerations like the availability of fertile soil and potable water. This is understandable by the fact that mostly all the sites in the district were located on the banks of rivers and fresh water lakes. As a matter of fact sites were located all over the district (Fig 1) but the concentration of sites was observed in Kalavad, Lalpur, Jamnagar, Kalyanpur and Jodiya talukas associated with black soils. The black soil with its moisture retaining capacity and its ability to be ploughed with simple instruments seems to have influenced the Harappans, as indicated by Possehl also (Possehl 1980 : 50-53). This goes to indicate that the main economic component of Harappan life was agriculture. However, the sites discovered in Okhamandal and Bhanvad talukas, which are quite drought prone and agriculturally discouraging, demand explanation here. Okhamandal taluka has alkaline soil conditions and Bhanvad taluka, which is highly mountainous with only 23 cms soil cover is not agriculturally very encouraging. The location of the settlements in these areas seems to have been conditioned by the easy accessibility to raw material for the development of industrial centres. This fact is supported by the presence of large quantities of shell and lithic artifacts and their manufacturing waste representing factory sites. Bhanvad, Jodiya and Lalpur talukas have fine pockets of agate and chalcedony, thus supporting the development of lithic factory sites. Okhamandal taluka was occupied by fishermen and craftsmen of the shell industry, due to the easy access to raw shell. Thus the sites like Nageswar, Beyt, Rupamora, Bhangor, Godowari and Tarana seems to have dependent upon its industry and trade rather purely on agriculture.

The close overlap of late Harappan at Nageswar indicate a common approach to the selection of these sites. The guiding factors were considerations like communication and availability of raw shell. A similar late Harappan site at Hangali (Rajkot district) also seems to have developed due to similar considerations. (Chitalwala 1976 : 94). Thus it appears that overall, fertile soil, easy accessibility of water and raw material and functional considerations like communication determined the site location of the Harappans.

Harappa culture was followed by historic periods in the district. However, archaeologically there appears to be a gap of nearly 900 years. According to Bhagvata, Harivamsa, Jain and Buddhist Literature, the Yadavas under Krishna migrated from Mathura to Dwarka which was known as Kusasthali then. Considering the entire literary evidence in the light of excavations at Dwarka proves that the site of present Dwarka was known by this name at least by the beginning of the Christian era and the legend about its being drowned has a factual base. However, its association with Shri Krishna and the Yadavas remains unproved (Sankalia 1970 : 54). Therefore, this episode has to be treated as protohistoric or better, legendary or traditional, until some facts are available for its acceptance.

C. HISTORIC PERIOD

Historic Period—I

History in modern sense begins with the conquest of Saurashtra under Chandragupta in 320 B.C. which can be inferred by the existence of fourteen rock edicts of Ashoka at the foot of Mount Girnar at Junagadh.

The Mauryan rule ended in about 200 B.C. and from 200 B.C. to 100 B.C. possibly Sungas, early Andhras or Satavahana and Indo-Greeks had by turn held Gujarat-Saurashtra (Sankalia 1941 : 8-9). However, nothing tangible is known about the nature of the occupations in the district.

In about 100 A.D. a branch of the Sakas are found to be ruling over Maharashtra and possibly Gujarat-Saurashtra. The excavation at Dwarka has shown that Dwarka was probably first inhabited during Saka occupation. (Sankalia 1970 : 55). It is represented by Black on Red ware, which has been dated to 1st/2nd century B.C. at Dwarka, on the basis of its being anterior to the layers containing Red Polished Ware (Ansari *et. al.* 1966 : 29).

Nearly 12 sites represented this period in the district. It is also possible that some more sites represent this period. The basic difficulty in locating such sites is due to the presence of Black on Red Ware in the succeeding Historic Period-II also. Two main criteria were used to differentiate between the Historic periods-I and II.

(1) The absence of Red Polished Ware from the sites yielding Black on Red Ware and (2) presence of typical decorated pots (Fig. 2) with out-turned rim with ledged band below having triangular decorations on the borders of the pots. Such pots have been reported from Dwarka (Ansari *et. al.* 1966 : 67. Fig. 17 : 3), Rangmahal (Hanna 1959 : 37, 31) and Taxila (Ghosh 1952 : Fig. 16). This type of decorated vessel is not reported from the succeeding periods. However, there are no measures to evaluate these collections in terms of sampling error. It can only be said in this regard that the collections were made in sufficient quantity so that mistakes of a gross nature are unlikely.

An inscribed pot-sherd in Maurayn Brahmi from Beyt has been assigned to this period. (Majumdar 1960 : 93, 94). Besides some iron pieces, shell bangles, terracotta balls and stoppers have been found with Red slipped ware, Coarse red ware and Black ware during excavations at Dwarka (Ansari *et. al.* 1966 : 41-52). The Black and Red ware, which is associated with iron has not been reported from the district till now, probably, because of the limited nature of excavated sites. However, this phase has been represented at number of places in Saurashtra like Somnath (Nanavati *et. al.* 1977 : 17) and therefore it is most likely that some of the sites of the Jamnagar district may represent this phase. The matter needs further investigation in the form of excavations.

Historic Period—II

This period covers a time bracket of 5 centuries starting from the early centuries of the Christian era. During the earlier part of this period Saurashtra was recaptured from the Satavahanas by the second Kshatrapa dynasty known as western Kshatrapas. They ruled Saurashtra and Gujarat for about 200 years. After the Kshatrapas Gujarat and Saurashtra were held by the Gupta dynasty, which is attested by the inscriptional (Fleet 1963 : 1) as well as numismatic (Parikh *et. al.* 1972 : 193) evidence. Jamnagar district seems to have formed a part of the Gupta empire upto 470 A.D.

The archaeological remains of this period are characterised by the presence of Roman Amphora Ware, Red polished Ware and Black on Red Ware. These ceramic remains are supplemented by terracota objects, stone sculptures, temple of Gop, Kshatrapa and Gupta coins and the inscriptions of Gunda (Bhanvad taluka) and Mulvasar (Okhamandal taluka). Most of the antiquities are surface finds ; they have been tentatively ascribed to this period in consideration of the typological similarities to the material remains of other explored or excavated sites.

Roman Amphora Ware was recovered from Dwarka, Fatehpur-I, Kota-II, Arla-I and Beyt. They seem to have been obtained from the Roman world during the beginning of the Christian era. As such their appearance at the sites can be ascribed to the first century A.D. (Mehta *et. al.* 1967 : 6). The presence of this ware throughout Western India indicates the brisk trade relations India had with the Mediterranean world during this period. These trade relations might have got a great impetus due to the many sheltered ports provided by the long coast line of the district.

An interesting pottery of this period is the Red Polished ware. It is associated with the Satavahana period in Maharashtra, Kushan period in Punjab and Kshatrapa period in Gujarat and Saurashtra (Subbarao 1956 : 57-61). As a matter of fact this rather typical Ware is to be found throughout India and almost at all the places its historic period-II dating is confirmed.

Another striking ceramic Ware of this period is Black on Red ware. It shows strong affinities with the pottery reported from Rangmahal (Hanna 1957 : 89-158). Rairh (Puri 1941), Waziristan (Stein 1929), Amreli (Rao 1966) and Vadnagar (Subbarao *et. al.* 1955 : 13). Chiefly the designs are geometrical and such geometrical designs are reported from the early (lowest) levels at Rangmahal (Hanna 1958 : 138).

Bricks measuring 37.5×30.7×5 cms were found at Brughkunda near Ghumli. Though other antiquities were not obtained from the site, the comparatively large dimensions of these bricks certainly suggest their antiquity of the Kshatrapa period. No other site has yielded bricks or any brick structure, eventhough at places sites are highly exposed due to digging and cultivation. Large numbers of dressed as well as undressed lime stone slabs were seen lying at some of the exposed sites and possibly indicate their being used for construction. This assumption is supported by the excavation at Dwarka where foundations of stone structures were found (Ansari *et. al.* 1966 : 33). The existence of a large number of stone quarries makes this type of material easily and cheaply available. It is still a common raw material for construction in rural as well as in urban areas of the district.

Two terracota spouts and a stone sculpture from Chachlana and Khakharda villages (Kalyanpur taluka) are interesting. They reveal distinct similarities with the terracota reported from Sambar (Bhan 1984 b). The idea of decorating pottery handles and spouts with human figures appears to have become popular with Indian potters during the first centuries of the christian era as a result of brisk trade with the western world. The Graeco-Roman metal pots possibly inspired the Indians to prepare handles and spouts in ceramics. Likewise, the terracotta figurine of a ram found from Bharana (Khabhaliya taluka) shows similar characteristics of modelling to that in the specimen from Rangmahal (Hanna : 1959 : 160) which is datable to early centuries of the Christian era.

While Junagadh claims the credit of having the finest and longest records, as well as the remains of monasteries of this period, the district of Jamnagar has yielded the stone inscriptions from Gunda (Banerji. *et. al.* 1922 : 233) and Mulvasar (Luders 1910 : 93) of the time of Rudrasimha and Rudrasena. These are dated respectively to 181 A D. and 200 A.D. The discovery of the Kshatrapa and the Gupta coins during present investigations also invaribly support the contention that the western Kshatrapas and the Guptas were in effective control of this region.

The Jamnagar district seems to have developed into a prolific centre of shell bangle manufacture during this period. Almost all the sites, belonging to this period have yielded a large quantity manufacturing waste and finished bangles of *T. Pyrum.* However, it is interesting to note that the technique for the manufacture of bangles and the type of saw used for cutting the shell seems to have remained unchanged since Harappan times. But now the bangles were more decorative and shell ladles possibly went out of fashion.

There is no significant change in the selection of the site location in Historic periods I and II. Nearly 81% of the sites of historic period I continued upto historic period II. Thus the settlement pattern of period II can be taken to be representative of period I also.

The total number of historic period II sites is 54 of which 15% are found on or near the late or devolved Harappa cultural settlements and 26% of sites are concentrated in the coastal areas.

The rest of the sites are situated well inland and a substantial number of these sites are to be found away from rivers or lakes.

The continuation of Historic period-II habitations on the Harappan sites. shows a common approach to the selection of location of the sites, mainly guided by the availability of fertile soils and water. Besides, a significant change in the pattern of distribution of settlements also took place during this period. A substantial number of sites are found away from rivers and lakes. This could possibly be due to the better technology available in the form of iron tools, which could have been effectively used for agricultural purpose.

The sites in coastal areas might have been developed to facilitate the trade relations of the district with the Mediterranean world. This fact is further substantiated by the presence of Roman Amphora Ware at Dwarka, Beyt and Bindara. Even today the sites like Dwarka, Beyt, Pindara, Lamba and Bedi are intermediate ports. Moreover, the discovery of a huge factory site for the shell industry at Beyt and the presence of shell manufacturing waste at almost all the 54 sites indicate that these coastal sites might have been developed not only because ot communication considerations but also due to the accessibility of immense quantities of marine resources to the ancient fishermen, and the craftsmen of the shell industry.

Historic Period—III

During Historic period-III the district of Jamnagar seems to have attained cultural and political stability. This is evident from the discoveries of a few epigraphs, sculptures, temples and habitational sites.

When Gupta power degenerated after the death of Skanda Gupta the Maitrakas of Valabhi on the east coast and the Garulakas in the west coast declared their independence. However, it appears that the Garulakas were ruling near Dwarka (Parikh 1972 : 46). In the eighth century we find a Saindhava family ruling over this area. It is the records of these which provide, for the first time some details of the history of Jamnagar district.

The six copper plates discovered in Bhanvad taluka at Ghumali (Altekar 1942 : 185-226) provide the history of Saindhavas and incidentally of western Saurashtra. The Saindhavas who originally were from Sind moved down to Kutch, crossed Western Saurashtra and took the protection of the Barda hills. The Barda hills attain a commanding position of 609.9m and run north south for nearly 32.2 kms paralled to the coast. This chain like formation made a natural fortification wall from which one could watch the movements of any invader in the Arabian Sea. The natural advantages provided by these hills possibly attracted the Saindhavas to establish ancient Bhumilika or Bhutambili or present Ghumali as their capital. They reigned for about 200 years providing a stable rule in Western Saurashtra.

Now the ceramic like Red Polished Ware and Roman Amphora disappears, suggesting that Roman contacts were absent. Burnished Red Ware along with some crude ware represent this period. Furthermore, there was an alround development in the field of art and architecture. The group of temples at Sonkansari, Pachhatar, and Pindara Ganesh drum at Ghumali, Koteshwar temple at Kalavad, a temple at Mevasa and some ruins at Bhuraghkunda near Ghumali and group of vishnu images near Sonkansari, Shiv-Parvati (Brhughkunda), Brahma, Ram, Shiv-Parvati and Vishnu images from Pindara represent this period (Nanavati *et. al.* 1950 ; Subbrahmanyam 1965 : 419-439).

The total number of Historic period III sites is 33 of which 34% of habitations continued from the Historic period-I and II. The rest of the sites were mainly concentrated around the Barda hills and in Okhamandal taluka. The continuation of habitations indicate that there was not much deviation in the pattern of settlements. The settlements around the Barda hills and in Okhamandal taluka seem to have been developed because of the strategic importance attached to these areas. The occupation of the area around Dwarka by the Garulaka dynasty and the development of Ghumali by the Saindhavas and later by the Jethwa family seems to have contributed to the development of a number of sites around these areas.

Historic Period—IV

The next cultural phase running between 10th to 13th century A.D. forms the historic period-IV. The discovery of the Baskaldeva grant of 989 A.D. indicates the reign of Baskaldeva over Ghumali. He possibly was from the Jethwa dynasty. The tradition connects the rule of Jethwas over the area upto 13th century A.D. The Navlakha temple, Rampora gate and Jethwa vav at Ghumali and Rukmini temple at Dwarka are typical examples of this period and show similarities with temples and gates found at Modhera, Siddhapur, Dabhoi and many other sites in various parts of Gujarat and Saurashtra.

The ceramic tradition of the earlier period continued during this period but with the introduction of a typical ware known as glazed ware. Besides the sculpture or architectural remains, which could be dated on stylistic grounds, were placed in this period.

What happened to Ghumali and the Jethwas ? Who destroyed them ? Nothing definite is known. However, it appears that Ghumali was destroyed by 15th century A.D. probably by the Jams of Sind who developed Jamnagar as their capital.

Thus the archaeological remains obtained from the various parts of the district, provide sufficient data to assert the main cultural currents right from the Lower Palaeolithic period to 1300 A.D. From the foregoing discussion it also appears that in general there was preference for the areas with better environmental conditions, good soils, economic resources and geo-strategical locations. These natural incentives provided by the district seems to have attracted people from Sind, Gujarat, Malwa, Rajasthan and Deccan.

Besides trade relations with Mediterranean world had also been maintained. This gave rise to a medlay of races and cultures in the district and as a matter of fact in the whole of Saurashtra. Ethnographically also Saurashtra has shown this great mix to this day. This fact is further substantiated by the names of persons, kings, queens, writers, composers, brahmans and merchants, mentioned in the Saindhava inscriptions.

ACKNOWLEDGEMENTS

I am thankful to Professor R.N. Mehta and Professor K.T.M. Hegde for their guidence and encouragement during the completion of the present work. Ajit Prasad, a research scholar of the Department also shares in my thanks for his constructive criticism and help. I am also grateful to the authorities of the Archaeological Survey of India for providing the financial assistance to carry out the explorations in Jamnagar district.

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Brief Information about Archaeological Sites of the Jamnagar District

Sl. No.	*Site*	*Coordinates*	*Number in the Map*	*Period*	*Remarks*
				TALUKA-BHANVAD	
1.	Ambhliyar	21°60′; 69°42′	1	Harappan (IIB-C)	
2.	Bhangor-I	22°05′; 69°49′	2	Harappan (IIB-C)	Lithic factory site
3.	Bhangor-II			Historic Period-I and II	
4.	Bhanvad	21°60′; 69°49′	3	Mesolithic	
5.	Bodki	21°60′; 69°50′	4	Historic Period-III and IV	
6.	Fatepur-I	22°0′; 69°45′	5	Historic Period-II, III and IV	
7.	Fatepur-II			Historic Period-II, III and IV	
8.	Ghumali	21°52′; 69°46′	6	Historic Period-II, III and IV	
9.	Ghunda	22°0′; 69°40′	7	Historic Period-II	Inscription of Kshatrapa period
10.	Hathlaj	21°53′; 69°36′	8	Historic Period-II	
11.	Krishenguda	21°50′; 69°55′	9	Mesolithic	
12.	Kabarka	21°56′; 70°0′	10	Historic Period-IV	
13.	Kalavad-I	21°54′; .69°50′	11	Historic Period-IV	
14.	Kalavad-II			Historic Period-II	
15.	Mevasa	21°54:5′; 69°50′	12	Historic Period-II, III and IV	
16.	Morpur-I			Mesolithic	
17.	Morpur-II	21°53′; 69°56′	13	Mesolithic	
18.	Morpur-III			Mesolithic	
19.	Pachthar	21°52′; 69°40′	14	Historic Period-I, II and III	
20.	Ranparda	21°56′; 69°44′	15	Harappan (IIB-C)	
21.	Rupamora	21°60′; 69°45′	16	Harappan (IIB-C) and Historic period-II	Lithic Factory Site
22.	Sai-devaliya	22°0′; 69°46′	17	Harappan (IIB-C) and Historic Period-II	
23.	Trivani-Sangam	21°50′; 69°49′	18	Mesolithic	
24.	Verad-I	21°55′; 69°51′	19	Historic Period-II and III	
25.	Verad-II			Historic Period-III & IV	
26.	Vijaypur	21°50′; 69°49′	20	Lower Palaeolithic	
				TALUKA-JAMJODHPURA	
27.	Dharfa-I	22°56′; 70°7′	21	Historic Period-II, III and IV	
	Dharfa-II			Historic Period-III & IV	
28.	Meghpura	22°18′; 69°30′	22	Historic Period-II	

Sl. No.	*Site*	*Coordinates*	*Number in the Map*	*Period*	*Remarks*
29.	Moti Gop	22°19'; 69°30'	23	Harappan (IIB-C)	
30.	Narmana-I	22°15'; 70°65'	24	Harappan (IIB-C)	
31.	Narmana-II			Harappan (IIB-C)	
32.	Valasan	22°57'; 70°6'	25	Historic Period-II and III	
33.	Zinawari Gop.	22°57'; 70°6'	26	Historic Period-II	
			TALUKA-JAMNAGAR		
34.	Alia-bada	22°8'; 69°7'	27	Harappan (IIB-C) Historic Period-II, III and IV	
35.	Amra	22°16'; 69°56'	28	Harappan (IIB-C) Historic Period-II, III and IV	
36.	Bedi	22°33'; 70°02'	29	Harappan (IIB-C) Historic Period-II, III and IV	
37.	Jambuda	22°32'; 70°10'	30	Historic Period-II, III and IV	
38.	Jivapar		31	Harappan (IIB-C)	
39.	Gangajala	22°29'; 70°12'	32	Historic Period-II and III	
40.	Khimsara	22°28'; 70°8'	33	Historic Period-II and III	
41.	Lakhabaval	22°24'; 70°0'	34	Harappan (IIB-C) Historic Period-II, III and IV	Excavated
42.	Mora	22°28'; 70°14'	35	Harappan (IIB-C)	
43.	Phala	22°18'; 70°32'	36	Harappan (IIB-C)	
44.	Shekhapat	22°25'; 70°18'	37	Historic Period-II and III	
45.	Vasai	22°24'; 70°00'	38	Harappan (IIB-C) Historic Period-II, III and IV	Excavated
46.	Virpur	22°24'; 69°58'	39	Harappan (IIB-C)	
			TALUKA-JODIYA		
47.	Anada	22°58': 70°19'	40	Middle Palaeolithic	
48.	Balamba	22°40'; 70°20'	41	Harappan (IIB-C)	
49.	Bodaka	22°20'; 70°30'	42	Harappan (IIB-C)	
50.	Hadiyana-I			Harappan (IIB-C)	
51.	Hadiyana-II	22°35'; 70°15'	43	Historic Period-II and III	
52.	Hadiyana-III			Historic Period-IV	
53.	Kotharia	22°47'; 70°30'	44	Historic Period-I	
54.	Kunad	22°39'; 70°18'	45	Historic Period-IV	

Sl. No.	*Site*	*Coordinates*	*Number in the Map*	*Period*	*Remarks*
55.	Manpar		46	Historic Period-IV	
56.	Pithad-I	22°41′; 70°32′	47	Harappan (IIB-C)	
57.	Pithad-II			Historic Period-III	
58.	Rasnal	22°41′; 70°35′	48	Harappan (IIB-C)	
59a.	Tarana-I			Middle Palaeolithic	
59b.	Tarana-II	22°43′; 70°27′	49	Harappan (IIB-C)	
59c.	Tarana-III			Harappan (IIB-C)	Lithic Factory Site
59d.	Tarana-IV			Harappan (IIB-C)	

TALUKA-KALAVAD

Sl. No.	*Site*	*Coordinates*	*Number in the Map*	*Period*	*Remarks*
60.	Arla-I	22°8′; 70°17′	50	Historic Period-II	
61.	Arla-II			Historic Period-III	
62.	Balamdi	22°8′; 70°25′	51	Harappan (IIB-C)	
63.	Bava-Khakaria-I			Harappan (IIB-C)	
64.	Bava-khakaria-II	22°14′; 70°24′	52	Historic Period-IV	
65.	Bhagadi-Mota		53	Harappan (IIB-C)	
66.	Bhagadi-Nana			Historic Period-IV	
67.	Dhandhoraji-I		54	Historic II and III	
68.	Dhandhoraji-II			Historic Period-IV	
69.	Dudhala	22°14′: 70°17′	55	Harappan (IIB-C)	
70.	Jasapar	22°12′; 70°25′	56	Harappan (III)	
71.	Jivapar	22°12′; 70°22′	57	Harappan (IIB-C) ?	
72.	Kalavad-I			Middle Palaeolithic	
73.	Kalavad-II			Harappan (IIB-C)	
74.	Kalavad-III	22°12′; 70°22′	58	Harappan (IIB-C)	
75.	Kalavad-IV			Harappan (IIB-C)	
76.	Lolai	22°12′; 70°14′	59	Harappan (IIB-C)	
77.	Machalivad-I			Mesolithic	
78.	Machalivad-II		60	Historic Period-II	
79.	Machalivad-III			Historic Period-III	
80.	Motavadala		61	Historic Period-III	
81.	Nikawa-I	22°11′; 70°36′	62	Harappan (IIB-C)	
82.	Nikawa-II			Historic Period-IV	
83.	Pithadia		63	Harappan (IIB-C)	
84.	Rajda	22°9′; 70°32′	64	Harappan (III)	
85.	Sarwania-I	22°9′; 70°22′	65	Harappan (IIB-C)	

Sl. No.	*Site*	*Coordinates*	*Number in the Map*	*Period*	*Remarks*
86.	Sarwania-II			Mesolithic	
87.	Shishang	22°12′; 70°28′	66	Historic Period-II	

TALUKA-KALYANPUR

Sl. No.	*Site*	*Coordinates*	*Number in the Map*	*Period*	*Remarks*
88.	Asota-Moto	22°16′; 69°23′	67	Historic Period-IV	
89.	Bamansa	22°6′; 69°11′	68	Historic Period-II and III	
90.	Bhaitia	22°6′; 69°16′	69	Historic Period-IV	
91.	Chachlana	22°55′; 69°22′	70	Historic Period-III	
92.	Chandravada-I			Harappan (III)	
93.	Chandravada-II	21°50′; 69°25′	71	Historic Period-II and III	
94.	Chandravada-III			Harappan (III)	
95.	Gandhavi	21°50′; 69°22′	72	Historic Period-III and IV	
96.	Kalyanpur-I			Historic Period-II and III	
97.	Kalyanpur-II	21°41′; 69°25′	73	Historic Period-II and III	
98.	Kalyanpur-III			Harappan (III)	
99.	Khakharda-I	22°5′; 69°22′	74	Historic Period-I, II and III	
100.	Khakharda-II			Historic Period-IV	
101.	Khijadad	22°5′; 69°11′	75	Historic Period-III	
102.	Lamba	21°33′; 69°18′	76	Historic Period-II and III	
103.	Limdi	22°11′; 69°20′	77	Historic Period-I and II	
104.	Nandana	22°8′; 69°17′	78	Historic Period-III and IV	
105.	Nagadia	21°55′; 69°33′	79	Mesolithic and Harappan (III)	
106.	Pindara	22°15′; 69°14′	80	Historic Period-II, III and Middle Palaeolithic (?)	
107.	Ranparda	21°55′; 69°23′	81	Harappan (IIB-C)	
108.	Raval	21°50′; 69°29′	82	Historic Period-IV	
109.	Suryavadar-I	21°56′; 69°45′	83	Harappan (IIB-C)	
110.	Suryavadar-II			Historic Period-I, II and III	
111.	Tankaria	21°56′; 69°25′	84	Harappan (IIB-C)	

TALUKA-KHAMBHALIA

Sl. No.	*Site*	*Coordinates*	*Number in the Map*	*Period*	*Remarks*
112.	Bharana-I	22°23′; 69°41′	85	Historic Period-II and III	
	Bharana-II			Historic Period-III and IV	
113.	Dantrana	22°11′; 69°25′	86	Historic Period-IV	
114.	Kota-I	22°10′; 69°42′	87	Harappan (IIB-C)	
115.	Kota-II			Historic Period-II and III	

Sl. No.	Site	Coordinates	Number in the Map	Period	Remarks
116.	Lalparda	22°1′; 69°38′	88	Historic Period II	
117.	Sinhanvadala	22°13′; 69°12′	89	Historic Period III	
118.	Vathara-I	22°11′; 69°32′	90	Historic Period II and III	
119.	Vathara-II			Historic Period IV	
120.	Zakasia	22°14′; 69°11′	91	Historic Period IV	

TALUKA-LALPUR

Sl. No.	Site	Coordinates	Number in the Map	Period	Remarks
121.	Arikhan-I	22°05′; 70°01′	92	Harappan (IIB-C)	Lithic Industry
	Arikhan-II			Historic Period-II and III	
122.	Dharampur	22°07′; 69°54′	93	Mesolithic	
123.	Jhakar	22°22′; 69°40′	94	Harappan (IIB-C)	
124.	Gajana	22°10′; 69°56′	95	Historic Period-II and III	
125.	Godavari-I			Mesolithic and Harappan (IIB-C)	
126.	Godavari-II	22°12′; 69°55′	96	Historic Period-II	
127.	Godavari-III			Historic Period-IV	
128.	Haripur-I	22°16′; 70°01′	97	Harappan (III)	
129.	Haripur-II			Historic Period-I	
130.	Morpur	22°16′; 69°49′	98	Harappan (III)	
131.	Pipartoda-I	22°02′; 70°05′	99	Harappan (III)	
132.	Pipartoda-II			Harappan (III)	
133.	Rampur	22°17′; 70°04′	100	Harappan (III)	
134.	Sewak-Bhatia-I	22°17′; 69°60′	101		
135.	Sewak-Bhatia-II			Historic Period-I	
136.	Sinach	22°20′; 69°44′	102	Harappan (IIB-C)	
137.	Veraval-Moti	22°17′; 70°04′	103	Harappan (III)	

TALUKA-OKHAMANDAL

Sl. No.	Site	Coordinates	Number in the Map	Period	Remarks
138.	Beyt	22°28′; 69°8′	104	Harappan (III) Historic Period-II, III and IV	Shell Industry
139.	Bhimrana	22°24′; 69°8′	105	Historic Period-IV	
140.	Dhinki	22°11′; 69°3′	106	Historic Period-III	
141.	Dhrevad	22°9′; 69°4′	107	Historic Period-III	
142.	Dhrasenvel	22°9′; 69°2′	108	Historic Period-II and III	
143.	Dwarka	22°15′; 69°0′	109	Harappan (III) Historic Period-II, III and IV	

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Sl. No.	*Site*	*Coordinates*	*Number in the Map*	*Period*	*Remarks*
144.	Gudhechi	22°11′; 69°2′	110	Historic Period-I and II	
145.	Kalyanpur	22°19′; 69°2′	111	Historic Period-IV	
146.	Kuranga	22°3′; 69°10′	112	Historic Period-II, III and IV	
147.	Mulvasar	22°16′; 69°10′	113	Historic Period I and II	
148.	Mulvel	22°10′; 69°7′	114	Historic Period IV	
149.	Nageswar	22°17′; 69°10′	115	Mature Harappan	Shell Industry (Excavated)
150.	Rajpura	22°22′; 69°5′	116	Historic Period I	
151.	Veraval	22°22′; 69°5′	117	Harappan (III), Historic Period-I, II and III	
152.	Wasai	22°19′; 69°0′	118	Historic Period-I, II and III	

KP - 1566

Landscape and Settlement pattern of Harappa Culture Villages in the Rupen Estuary

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INTRODUCTION

Diffusion of Harappa culture into Kutch and Saurashtra regions, Kheda and Ahmedabad Districts and further south into the Narmada and Tapi estuaries of Gujarat is well known (Rao 1962-63, Joshi 1972, Possehl 1980 and Momin 1984). But not a single site representing Harappa culture was reported from the fertile estuarine plain of the Rupen river, prior to the present survey. It was believed that on account of the semi-arid climate, agricultural communities did not settle in this area until they developed devices to control and conserve water in the early centuries of the Christian Era (Possehl 1975). Rao, based on his explorations observed that the area to the north of Surendranagar was not inhabited by the Harappans (Rao 1962-63, pp. 177-78).

However, a close study of the quarter inch map of survey sheet no. 41 M and the gazetteers of Mehsana and Surendranagar districts, covering this region revealed that the Rupen River estuary had much better hospitable environmental conditions in terms of the fertility of soil, mean annual rainfall, vegetation and availability of potable water round the year than those of Kutch or certain parts of Saurashtra where Harappan settlements have been noted by earlier explorers.

Landscape

The Rupen estuary is built up of alluvial silt and clay brought down by the Rupen river to its lower reaches. The Rupen along with her tributaries, which drain this area, rises from the western slopes of Taranga Hills and flows into the Little Rann of Kutch, where it is not affected by soluble salt-incrustation. The loamy soil of the plain is fertile. One of the welcome features of this area is the series of relict sand dunes. This was specially important for the immigrant Harappan communities who came from the Indus Valley which was subjected to frequent floods in the early centuries of the second millennium B.C. (Wheeler 1968). Even when they moved into Kutch and Saurashtra they invariably selected elevated grounds and rocky out crops for their settlements. The natural eminences in the form of relict sand dunes in the Rupen valley must have served as one of the most important geomorphic features which the Harappans looked forward to settle down. These relict sand dunes appear to have been formed, like the sand dunes of north Gujarat and Rajasthan in the late quaternary times in response to arid climatic conditions that prevailed in this region. These dunes were formed and stabilized before the Mesolithic hunter-gatherers appeared on the scene (Allchin et al 1978). They are covered by a soil rich in lime which supports a thicket type of vegetation consisting mainly of wild grass and acacia scrub. Before the recent period of intense human activity this vegetation would have been much more dense. The blow-out hollows on the slopes of these dunes accumulate monsoon runoff forming fresh water ponds. Occasionally these ponds are found to be quite large containing water round the year. Inspite of the present day intensive agriculture around these lakes, some of them retain considerable quantity of water during the summer months. They supply potable water to the villagers throughout the year.

It appeared to us that this fertile plain with its eminences of relict sand dunes whose heights are much beyond the threat of annual floods and availability of potable water round the year, might have been found to be favourable ecologically by migrating Harappan communities to settle in this area. Moreover, this plain is well connected with Kutch and northern parts of Saurashtra, across the Little Rann, through five well-drained routes or ridges locally known as bets. These land routes are suitable for movement during the summer months.

Exploration

Therefore a small test-area bound by Lat. 23°20′ to 23°45′ N. and Long. 71°45′ to 72°E. in the Lower Rupen Valley was selected for an intensive village to village survey to evaluate its archaeological potential. This work was an extension of the encouraging explorations carried out in the adjoining western part of the Mehsana district in 1979 jointly by the M.S. University of Baroda and the Archaeological Survey of India (Indian Archaeology 1978-79).

Problems

The present survey, which we intend to continue further was mainly conducted to seek answers to the following questions :

1. Whether the Harappan communities migrated into the Rupen River estuary.
2. If they did, would it be possible to reconstruct the routes that they used.
3. What was the material culture of the indigenous communities when the Harappans came in ?
4. How did the two communities confront each other ?
5. What are the distinctive cultural equipments of the immigrant Harappan community and its settlement pattern ?
6. Evidence of exploitation of indigenous natural resources like steatite, agate, chert and chalcedony nodules, copper ore and marine shells by the immigrant craftsmen.
7. Stratigraphy of the sequential stages in which distinctive Harappan traits disappeared.
8. Recognition of the distinctive material relics of the people who lived in this area after the disappearance of the later Harappan communities and before the appearance of the well governed administrative system through the governors of the imperial Mauryan kings in this region.

Results

Systematic exploration of the test area in the Rupen estuary brought to light twentyone Harappa culture settlements and a number of Mesolithic and Historic period sites (fig. 1 and appendix 3). In this exploration

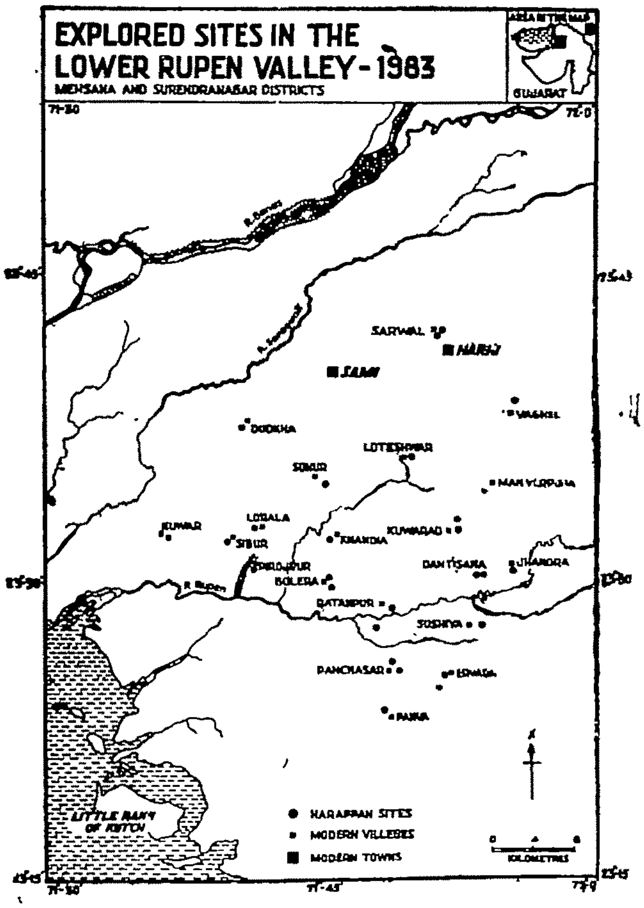
EXPLORED SITES IN THE
LOWER RUPEN VALLEY - 1983
MEHSANA AND SURENDRANAGAR DISTRICTS
GUJARAT
71°30
72°0
23°45
23°30
23°15
71°45
R. Rupen
SARWAL
SAMI
DUDKHA
LOTESHWAR
VAGHEL
KUWAR
LODALA
SIBUR
KHANDIA
KUWARAD
DANTISANA
JHANORA
BOLERA
RATANPOR
PANCHASAR
LITTLE RANN OF KUTCH
HARAPPAN SITES
MODERN VILLAGES
MODERN TOWNS
KILOMETRES

Fig. 1 : Map

we were very much supported by a number of persons like the school teachers, Sarpanch of the villages and elderly knowledgeable persons. At each village, after explaining our purpose of visit, we inquired about what we were looking for. The enthusiastic and knowledgeable among the villagers took us to a number of mounds littered with valuable archaeological records.

Every one of these twentyone Harappan sites shows almost identical material relics. Unfortunately most of these sites, except one which is at Ratanpur, are subjected to cultivation and hence found to be disturbed in state of preservation. Section scraping at some of these sites revealed shallow deposits of occupational debris ranging between 50 cm to 1.50 m. As far as the size of these habitational mounds is concerned none of them was beyond 200 sq. m. But though these ancient villages were small they have been found to be distributed close to each other. Such a closely knit settlements appear to have helped them in efficient agricultural operations and animal husbandry. The material relics gathered from the surface of these sites have yielded a wide range of diagnostic artifacts. The assemblage includes typical Harappan sturdy Red Ware alongwith its significant varieties in forms and fabrics, a variety of terracotta and stone objects, ornamental beads and shell bangles in association with manufacturing waste at a few sites beside animal bones. These material remains reflect upon the quality and life-style of the Harappan peasants who lived here.

Ceramic Industry

The ceramic industry of the Lower Rupen Valley mainly consisted of the sturdy Red Ware along with the chocolate slipped Ware, Buff Ware, Reserved Slip Ware and Lustrous Red Ware. There were also sherds of crude, ill-fired pottery. The Grey Ware of this coarse variety was occasionally decorated with incised designs. The characteristic white painted Black and Red Ware was recovered almost from all the sites while the representatives of polychrome and Rusticated Wares have been found from only a few sites.

The Harappan Red Ware (fig. 2 nos. 1 to 20, fig. 3, nos. 21 to 32 and fig. 4 nos. 33 and 34) is the most distinctive ceramic type of this group. Convex or concave sided bowls with everted rim and blunt or sharp carination, stud-handled bowls, dishes with beaded rim and unpronounced carination, corrugated stem portions of dish-on-stand, basins, jars with flaring neck, beaded rim and bulbous body, were some of the representative shapes found during the survey. The most recurrent painted motifs in black or brown on red include single or multiple horizontal bands, hatched squares or diamonds, intersecting loops and wavy lines. The forms of chocolate slipped ware (fig. 4 nos. 36 to 41) and Buff ware (fig. 4 nos. 42 to 48) though analogus to the Red Ware, their shapes display a limited range. This might indicate restricted use of these wares in these settlements. But both these wares show much diversity in their decorative motifs. The characteristic Reserved Slip Ware (Fig. 4 no. 35) decorated with horizontal wavy lines in red is represented by a solitary bowl obtained from Sarwal,

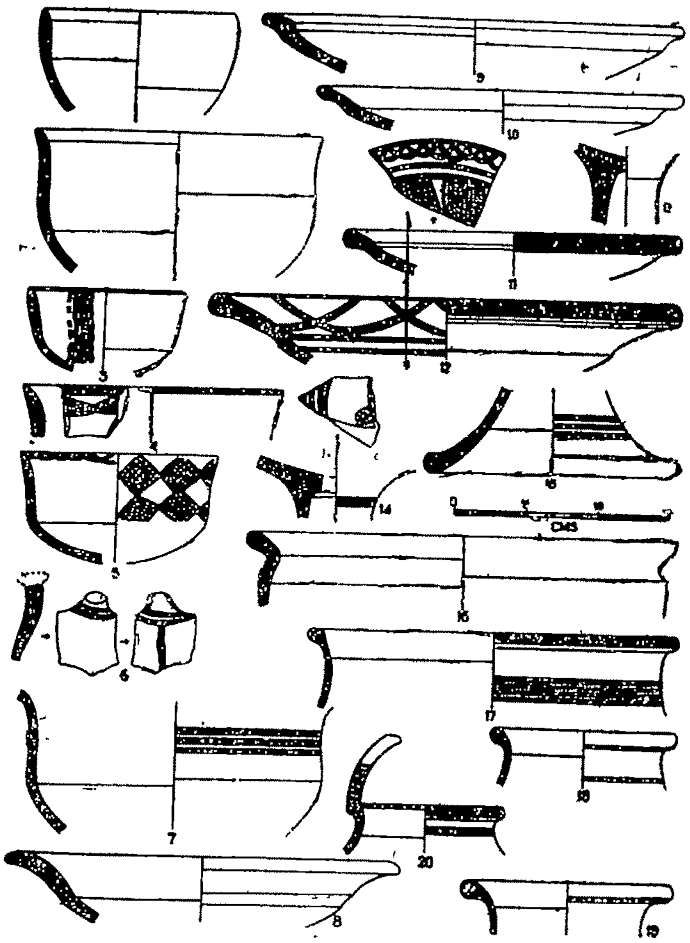

Fig. 2 : Rupen Valley : Red Ware Nos. 1-20

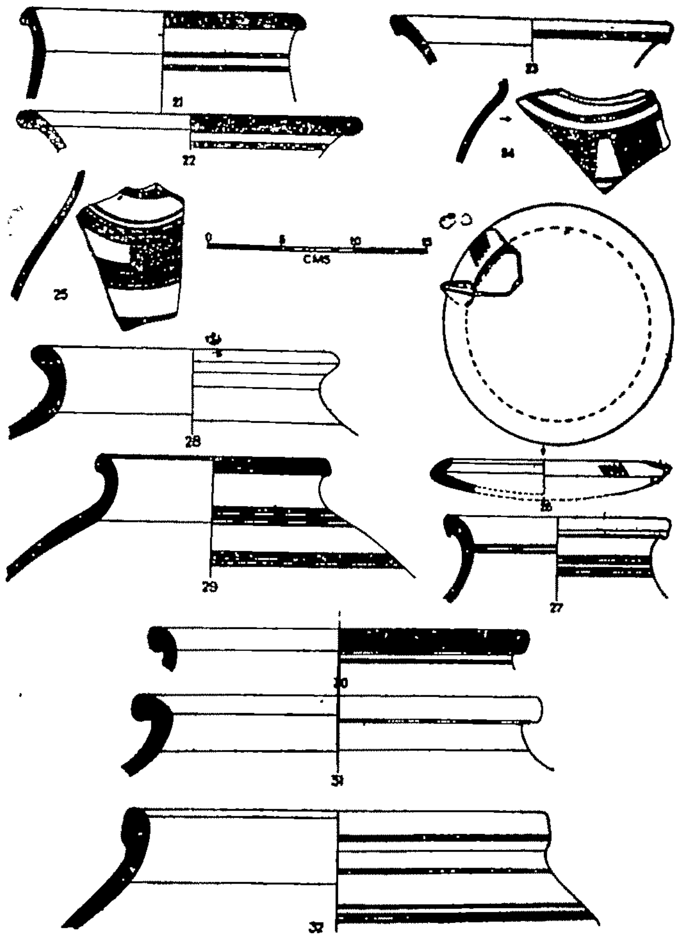
21
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Fig. 3
Rupen Valley : Red Ware Nos. 21-33

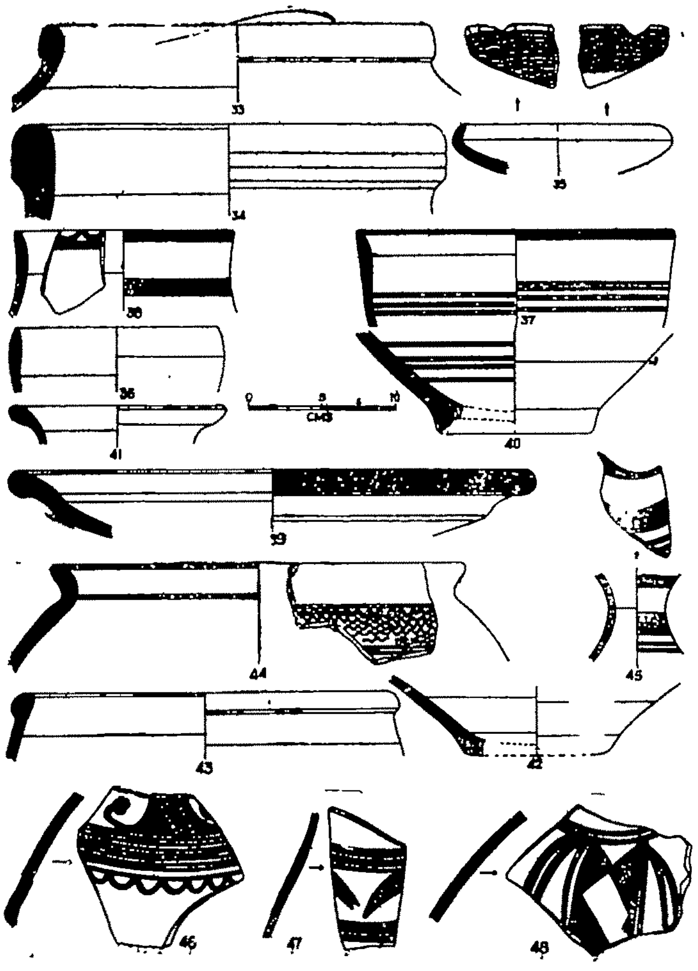
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Fig. 4
Rupen Valley : Red Ware Nos. 33-34,
Reserved Slip War No. 35,
Chocolate Slipped Ware Nos. 36-41,
Buff Ware Nos. 42-48.

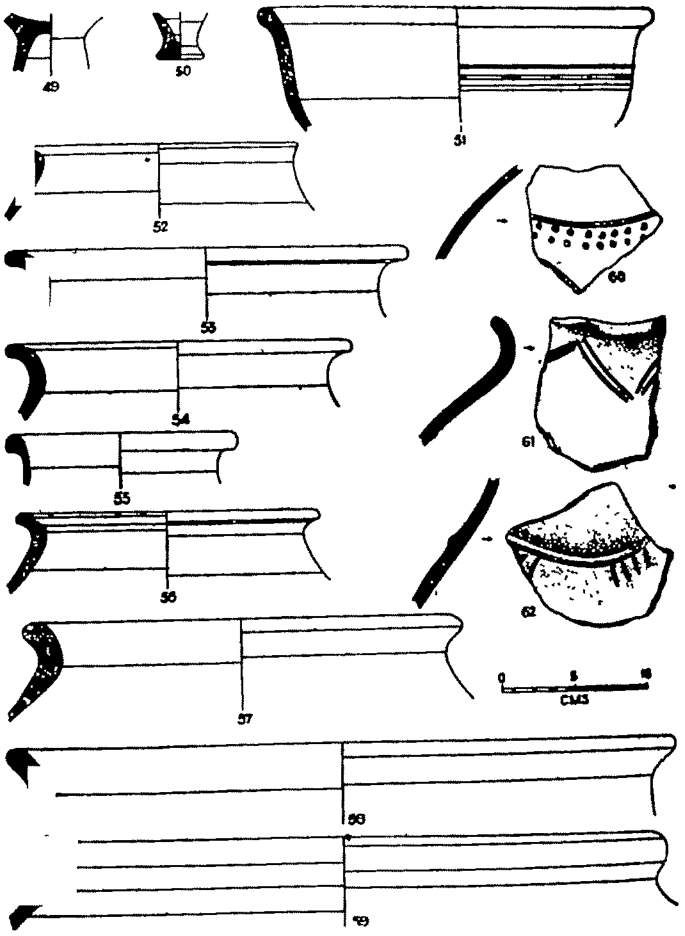

Fig. 5
Rupen Valley : Coarse Red Ware Nos. 49-59.
Coarse Grey Ware Nos. 60-62.

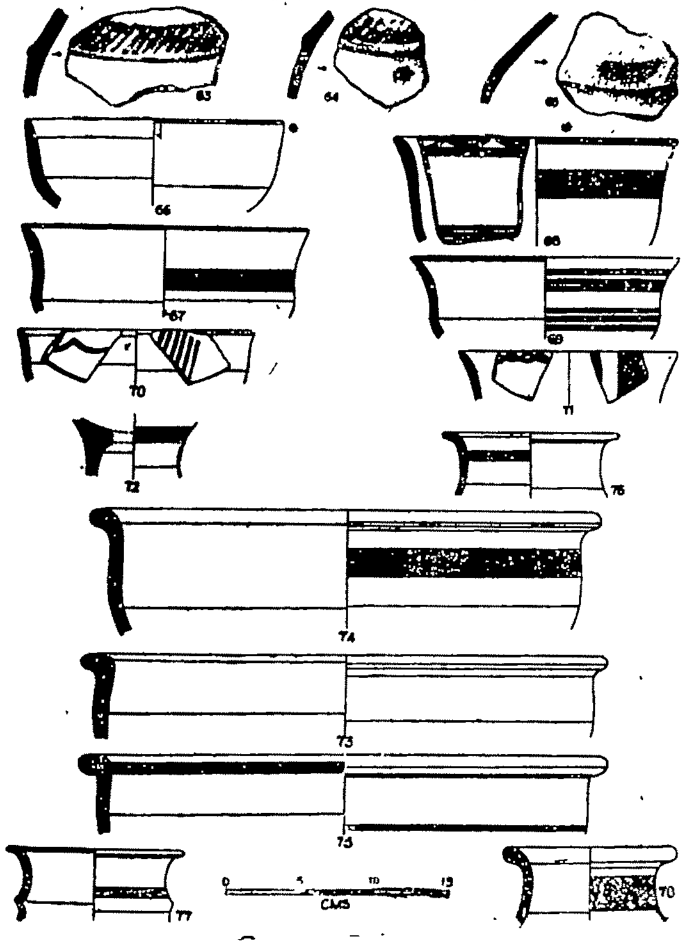

Fig. 6
Rupen Valley : Coarse Grey Ware Nos. 63-65,
Lustrous Red Ware Nos. 66-78.

Except for one goblet, a few basins and stem portions of dish-on-stand, rest of the pottery fragments of coarser Red Ware (fig. 5. nos. 49 to 59) display a wide variety of globular pots and jars, devoid of any decoration either painted or incised. The incised decorations were confined to coarse Grey Ware only (fig. 5 nos. 60 to 62 and fig. 6 nos. 63 to 65). The decorations comprised of dots, wavy lines, oblique strokes, slashes and finger tip marks. Lustrous Red Ware is one of the striking ceramic types of this area. In this fabric (fig. 6 nos. 66 to 78 and fig. 7 nos. 79 to 83) almost identical forms and decorations of the Red Ware are found to be reproduced. The main representative types in this ware are bowls, dishes, dish-on-stand, basins, high necked pots and wide mouthed jars. White painted Black and Red Ware (fig. 7 nos. 84 to 95) is another predomineant pottery type of this region. Bowls are more common in this ware. Among them the most prolific being concave sided bowls with everted rim and carinated shoulder. They are internally decorated with typical white painted designs consisting of straight, oblique and curved vertical bands. Besides these, there are a few sherds of polychrome Ware (fig. 7 nos. 96 to 98) and Rusticated Ware (fig. 7 no. 99) in the ceramic assemblage. The former is decorated with black or brown on white or cream slip, applied over natural mat surface, while the latter group includes sherds of globular pots of which lower exterior

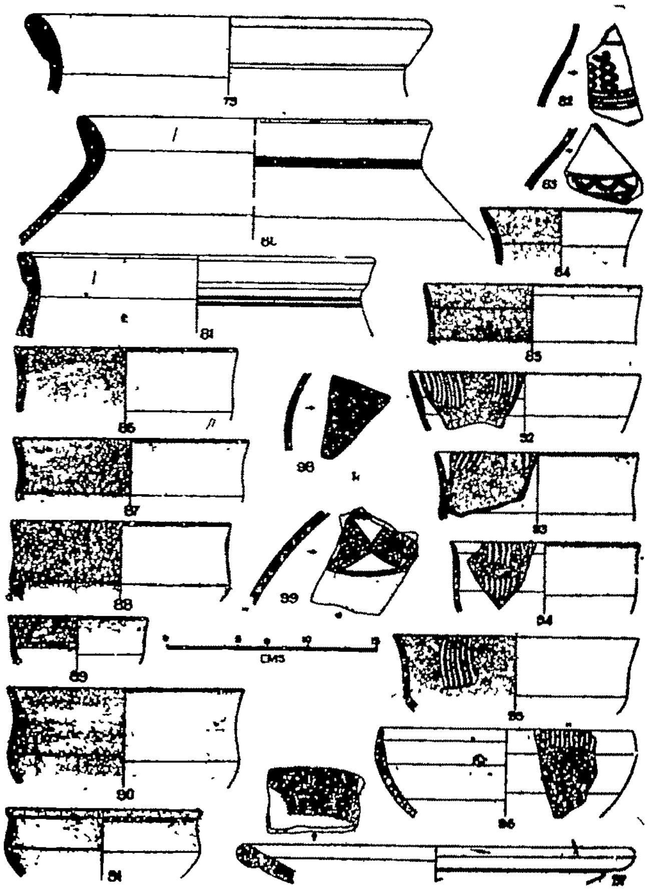

Fig. 7
Ruppen Valley : Lustrous Red Ware Nos. 79-83,
Black and Red Ware Nos. 84-95,
Polychrome Ware Nos. 96-98,
Rusticated Ware No. 99.

portion is artificially roughened up by applying a thin coat of a paste consisting of sand and clay.

The ceramic assemblage of the Lower Rupen valley is thus comparable to the pottery recovered from Rangpur period II B, II C and III (Rao 1962-63), Kanewal (Mehta et al 1980), Valabhi (Mehta 1984) and Zekhda (Momin 1983).

Other Antiquities

Among the other finds recovered from the area, terracotta objects (pt. I) form the major part. Of these, spherical lumps with two or four pinched impressions, mushtikas and oval shaped lumps with pointed ends were found at most of the sites. The typical triangular 'cakes' however were not found. The occurrence of terracotta cart wheels, spindle whorls, biconical circular objects without perforation, lamps, pottery discs are noteworthy.

The discovery of chank bangle fragments and beads of chank, carnelian, amazonite and dentalium shell is quite significant. The presence of manufacturing waste (pt. II) including *turbinella pyrum* columela and apex portions suggest local manufacture of shell artifacts at some of these sites. Manufacture of such shell artefacts is ably illustrated by Bhan and Kenoyer (1983). The necessary raw material in the form of marine shells for chank industry seems to have been obtained from the adjoining region of Gulf of Kutch. The presence of lithic artefacts consisting of household implements such as saddle querns and pestles alongwith sling balls, hammer stones and chert blades and cores is not without interest.

A preliminary study of the faunal remains gathered from these sites has revealed the presence of bones of domesticated animals like cow, buffalo, goat, sheep, pig and also of wild animals like barasinga and deer. Some of these bones bear sharp cut marks and few of them were also charred. These features indicate that these animals were reared or hunted to supplement the agricultural products.

Settlement Pattern

The pattern of settlement of Harappa culture sites in Gujarat appears to be mainly influenced by the varied geophysical features of the land. Their distribution concentrated in some parts and sparse in others. Harappans in their multi directional penetration have demonstrated their skill in selecting suitable environmental niches. Culturally and technologically they had developed certain skills and abilities for exploiting the available resources. This feature partly explains the regional diversities in their cultural equipments at different Harappan sites within Gujarat.

The pattern of settlements in the Rupen estuary is essentially based on their ability to exploit the agricultural potential of the loamy alluvial soil in the estuary. It was mainly geared to subsistence requirements. Therefore all the sites are located close to perenial fresh water lakes and found to be surrounded with cultivable land.

Employing intensive pattern of landuse they have established their settlements in closely spaced units, some times in groups of two or three settlements. The average distance between the two groups of settlements is not more than ten kilometers. The number of Harappan settlements in this area is about one half of the present villages in the area. This ratio gives an idea of the probable density of Harappan population in this area. All these twentyone Harappan sites found by us appear to be small villages, distributed in such a way as to bring about effective agriculture and cattle breeding. They are closely knit so that they are easily accessible to each other and probably participated in the social or religious functions of each other. Distribution pattern of these sites also indicates that the immigrant Harappan communities came from the Saurashtra region using the bets to cross over the Little Rann.

CONCLUSION

Preceding the arrival of Harappan communities this land was inhabited by the Mesolithic hunter-gatherers. There are numerous Mesolithic sites on the sand dunes in the Rupen estuary. These Mesolithic communities may have practised rudimentary animal husbandry but they did not use any pottery. Whether this indigenous population, living a nomadic life continued to live along with the immigrant Harappans or not will be established only after the excavation of some of these Harappa culture sites.

Coming to the Harappans, as has been said earlier, all of these sites display a rural way of life, mainly based on agrarian economy. Their pottery and small scale stone and shell manufacturing industries indicate their efforts towards self-sufficiency. All these sites show greater affinities in ceramic types and forms and also in other material remains with those Harappan assemblages of Saurashtra which are analogus to Rangpur period II B, II C and III, all assigned to the second half of the second millenium B. C.

It appears that there was a proliferation of such small village sites during the late Harappan period. Possehl (1980, p. 50) assigns the introduction of Bajara as one of the main factors for this wide distribution of late Harappan settlements in the Saurashtra region. This might hold good for this adjoining area also. Compared to Kutch the density of late Harappan population in Saurashtra is much more, and since our sites show much greater cultural affinities with the sites of Saurashtra than with those of Kutch it is possible to infer that the Harappan immigrants came to Rupen Valley from Saurashtra. The presence of Lustrous Red Ware, stud-handled bowl and manufacturing waste of shell artefacts of marine gastropods like *Turbinella Pyrum* appear to lend support this observation.

The occurrence of a few representative sherds of goblet, perforated jar at this juncture could be treated only as a lingering feature of the Mature Harappan traits. Certain vessels like bowl, dish-on-stand, and jar also underwent perceptible changes in their shapes. The ceramic assemblage in general show a degressive trend.

From the foregoing observations it is difficult to draw answers to all the questions we have raised above. Excavation at Ratanpur, Dudaka or Bolera may throw useful light towards this end. One of these excavations is now being planned for 1984-85 season.

ACKNOWLEDGEMENT

Our thanks are due to Dr. K. N. Momin and Messers R. J. Khatri, A. S. Pawar, S. Prathapa Chandran and K. V. Subbarao for their enthusiastic participation in the exploration and Dr. (Mrs.) D. R. Shah for the osteological analysis of the bone fragments collected during the exploration of Rupen Valley.

Appendix

List of the Harappa culture sites found in the Rupen estuary during 1983.

Site/Village/ coordinates		*Taluka*	*District*	*Remarks*
Bolera	23°29′ N. 71°51′ E.	Sami	Mehsana	
I Gorivatano Timbo				Shell Industry
II Kalarine Timbo				Blade Industry
Khandia	23°32′ N. 71°46′ E.	-do-	-do-	
I Thikariyano Timbo				
Sonur	23°35′ N. 71°45′ E.	-do-	-do-	
I Limdavalo Timbo				
Vaghel	23°38′ N. 71°54′ E.	-do-	-do-	Rich in terracota lumps.
I Atariyano Hanuman				
Loteshwar	23°36′ N. 71°49′ E.	-do-	-do-	
I Kharino Timbo				Rich in terracotta
Kuwarad	23°33′ N. 71°51′ E.	-do-	-do-	lumps.
I Sasiyano Timbo				
II Piriyano Timbo				
Manverpura	23°35′ N. 71°53′ E.	-do-	-do-	
I Vadadino Timbo				
Dhanora	23°31′ N. 71°54′ E.	-do-	-do-	
I Deriwalu Khetar				
Dantisana	23°30′ N. 71°53′ E.	-do-	-do-	
I Godhiyano Timbo				
Ratanpur	23°28′ N. 71°48′ E.	-do-	-do-	undisturbed
I Tokaria Timbo				

1	2	3	4
Panchasar 23°25′ N.	Sami	Mehsana	Blade Industry
71°48′ E.			Shell Industry
I Dudheriya Timbo			Rich in terracotta lumps
II Hartharno Timbo			
III Bagayano Timbo			
Sarwal 23°42′ N.	Harij	-do-	
71°51′ E.			
I Kathariyano Timbo			Reserved slip ware
II Borawalu Khetra			
Ervada 23°25′ N.	Dasada	Surendranagar	
71°51′ E.			
I Janoyano Timbo			
II Matajino Timbo			Shell Industry
Sushiya 23°27′ N.	-do-	-do-	
71°52′ E.			
I Gordhaniya Timbo			
Panva 23°23′ N.	-do-	-do-	
71°48′ E.			
I Oriyadadano Timbo			

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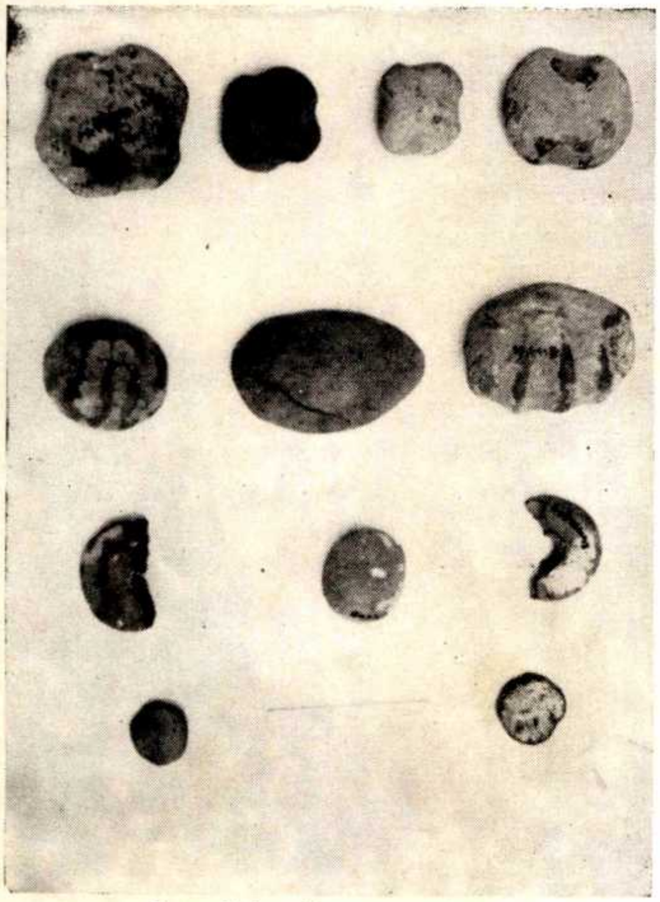
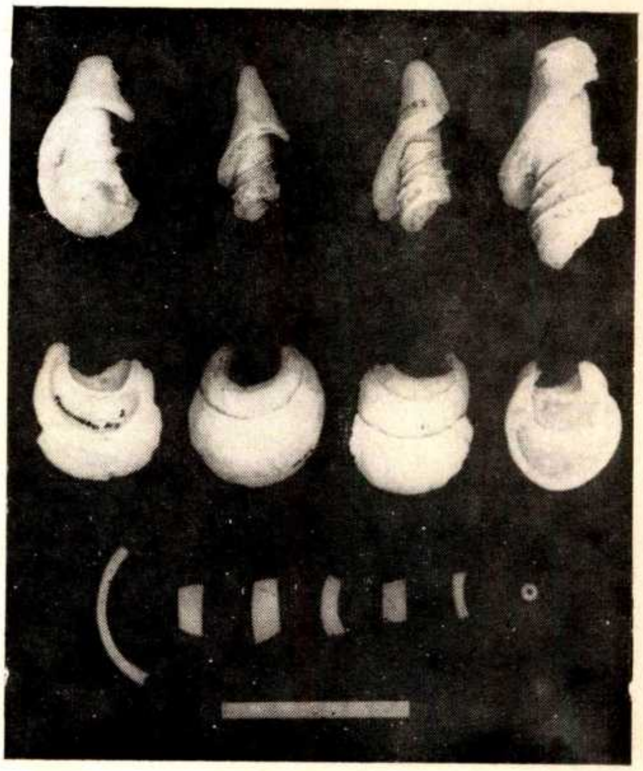


Rupen Valley : Terracotta objects.



Rupen Valley : Shell artefacts and manufacturing waste.

Reposte to Wasson's Sedimentological Basis of the Mohenjo-Daro Flood Hypothesis

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INTRODUCTION

The long-simmering debate over the subject of flooding at Mohenjodaro has been rekindled by R.J. Wasson in MAN & ENVIRONMENT VIII (1984). Wasson contends, using sedimentological arguments only, that "there is no need to view the sediments at Mohenjo-daro as anything but overbank alluvium..." and that we are seeing nothing more than "simply" the normal behaviour of a big river".

These conclusions indicate a serious miscomprehension of the problem and of the total evidence-albeit incomplete-used by the authors in emphasizing the decisive role of an unusual tectonically induced flooding phenomenon, and particularly in the truly vast sedimentation anomaly that Raikes refers to below, in the decline and abandonment of Mohenjo-daro (Raikes 1964, 1965, 1967, 1979, 1984 ; Raikes and Dales 1977 ; Dales 1965a, 1965b, 1965c, 1966 ; Dales and Raikes 1968).

Before coming to Mr. Raikes's specific rebuttal to Wasson's criticisms, we would like to reiterate our general position on the larger issues as they apply to the Indus Civilization. As stated in an earlier article (Raikes and Dales 1977 : 259), everyone since Sir John Marshall concerned with the problem of the abandonment of Mohenjo-daro has agreed that there were floods and most believe that they played their part in weakening the civilization. There is even general agreement about the catastrophic and wide-spread nature of the floods in the lower Indus region. But there is plenty of disagreement about what caused the floods,

As has been emphasized in all our articles, "normal behaviour of a big river" simply cannot account for the evidence of massive flooding at Mohenjo-daro. It is somewhat frustrating, and a pity, that the criticisms continue to revert to subjects such as grain size rather than focus on trying to understand the social, economic and cultural impact of the flooding phenomenon on the inhabitants of Mohenjo-daro and the smaller settlements in the lower Indus plain. This broader issue has been addressed in detail by Mr. Raikes (1984 : 455-460) in an article apparently not available to Dr. Wasson.

Various scholars and scientists have commented on the role of natural forces not just at Mohenjo-daro and the lower Indus region but in the entire area encompassed by the Indus civilization. Agrawal and Sood (1982), for example, have discussed in detail the evidence for natural catastrophies in the Harappan realm and conclude that "It is obvious...that ecological stresses, caused both climatically and tectonically, played an important role in the life and decay of the Harappan civilization."

But ecological stress, in itself, need not bring down a mighty civilization, as the history of empires demonstrates. As questioned by one historian (Bloch 1953 : 24) "Does the physical ever effect the social unless its operations have been prepared, abetted, and given scope by other factors which themselves have already derived from man ?"

Does this not highlight issues more significant than grain size and flooding "mechanisms" ? But Wasson's criticism requires a rebuttal that is offered here by Mr. Raikes.

By way of introduction, Raikes supervised preliminary studies on the flooding hypothesis at Mohenjo-daro in 1964 and 1965 in conjunction with the University Museum, University of Pennsylvania's archaeological project. Sediments and other non-architectural strata were studied *in situ* at numerous locations around the entire site during the preliminary survey program in early 1964. Then, in November 1964, Raikes arranged for a series of bore holes to be sunk at the site in conjunction with the University Museum's excavations along the western edge of the HR area. A contract was negotiated with the Indus Valley Construction Company of Lahore for the coring equipment and operators and for the analysis of soil samples.

Bore hole ≠1 was sunk at plain level about midway between the HR area and the Citadel mound. The elevation (above mean sea level) of plain level at that point was 47.32 meters (155 feet 3 inches). Observations in the field by Raikes noted that the core samples ranged from clayey-silt to silty clay. No apparent architectural features or *in situ* habitation levels were encountered but pottery sherds were recovered to a depth of 12.5 meters (41 feet) below plain level.

Bore hole ≠2 was located at plain level at the base of HR mound in the area of the new excavations. Corings went to a depth of 16.56 meters (54 feet 4 inches). Ground level at this point was 49.25 meters (161 feet 7 inches). Sherds and other human artifacts stopped at a depth of 12.57 meters (41 feet 3 inches).

Bore hole ≠3 was sunk at plain level a few meters from the base of the southwest edge of HR mound. No architectural features were encountered to a depth of 9.8 meters (32 feet 2 inches), but see the Postscript below.

Other soil samples were collected from the new excavations on the crest of the HR mound. Two of the analysed samples, from 7 a dn 8 inches below the surface of the mound, are described here.

Selected soil samples were taken immediately to Lahore for testing. The results of the Atterberg limits tests and the corresponding grain-size distribution curves for six samples are given here in Raikes's Reposte,

Raikes's Reposte

I normally use the M.I.T. system of grain-size definitions. However, for Mohenjo-daro the analyses were carried out through a contractor, the Indus Valley Construction Co., whose laboratory used sieve sizes 200 (to the inch=0.075 mm), 100, 50, 30, 16, 8 etc. and larger (½ inch and more mesh) sieves. The 200 sieve, according to the system used by the contractor, passes all material less than 0.075 mm, i.e. everything smaller than M.I.T.'s fine sand (between 0.06 and 0.12 mm) and all was described as "silt or clay" Using the millimetre scale of the gradiation curve diagram, "silt or clay" composed the following percentages of the only samples that were available before I left Pakistan (in practice, this meant the only ones ever available as, in the climate of those days [1960's], the sending of this sort of information out of the country could lead to complications for the sender : subsequent attempts to obtain the rest of the tests were unsuccessful). Of course grading analyses are of extremely limited value because of lumping clay and silt together but the Atterberg limits tests increase their value and allow rough definitions as follows :

Borehole No.	*Serial No. of Sample*	*Depth from Surface*	*Percentage in Silt & Clay Fractions (1)*	*Atterberg Description (2)*
1	4	3.5-5.0	52	Inorganic silt/ clay of low Plasticity (with many sherds)
1	5	5.0-6.1	94	Inorganic silt/ clay of low compressibility/ plasticity
1	6	6.1-11.0	85	Inorganic silt/ clay of medium compressibility/ plasticity
3	7	9.0-9.8	82	Inorganic silt/ clay of low compressibility/ plasticity
Sample from crest of HR area in new excavations		7″ below surface	86	Inorganic silt/ clay of low compressibility/ plasticity
Sample from crest of HR area in new excavations		8″ below surface	86	Inorganic silt/ clay of low compressibility/ plasticity

Of course the the limits, whether those of M.I.T. or Wasson, are arbitrary and take account of the immense variability in some materials : e.g. a material which just grades as silt behaves increasingly like clay when derived from certain minerals and of course there is no sudden break or change.

Wasson's display of detailed but apparently irrelevant technical knowledge (for this problem) covers a wide variety of rivers, none of which in the least resembles the Indus. The Indus, Ganges and Brahmaputra are in a class by themselves in that they derive practically all their flood flow from Hindu Kush-Himalayan glacier-melt in summer (with a little monsoon-derived run-off thrown in for good measure). No other rivers of comparable size (Nile, Amazon) and comparable base flow, enjoy such an abundant source of both water and fine sediments and yet the percentage of material, shown in the Mohenjo-daro analyses as being silt and clay, is very similar to and certainly within the range of that for the Barwon River, rivers of South Dakota and the Mississippi, rivers of New South Wales, the Amu Darya and the Rhone.

I think Wasson overlooks that the study was carried out for archaeologists and published with archaeological readers in mind. To those who have not made sedimentology their speciality, "still water" conditions conjure up the picture intended, of anything from a pond to a lake but complete with the waves and wind that make these popular for wind-surfing and the gentle currents all too familiar to fishermen and aqualung enthusiasts. I meant, and still mean, still water as opposed to a normal river with fluviatile flooding (and even these have still-water conditions in the back swamps). I will come to the main scientific reason for this simplification in a moment.

Wasson could have assumed with reasonable certainty that a hydrologist would not totally omit considerations of grain sizes, but I can assure him that they are not the sort of diet that appeals to archaeologists and so were not published in our earlier reports. Under the sub-heading of GRAIN-SIZE, Wasson asserts that my argument about a lacustrine environment demands that silt/clay particles should not be found in alluvium without coarser particles. If I had made an assertion of this kind it would have been less convoluted : I would have said quite simply that "particles of this size are found with coarser particles." The grading curves indeed show that this is the case. My argument that "silt-clay" is deposited in still water (incidentally any still water, including back swamps) did not *imply* a lacustrine environment, it specifically *required* it. It am not sure, even now, after reading that sentence of Wasson's many times, what it means nor am I clear as to whose assertion is false or even what exactly the assertion was.

But all this is water under the bridge, so to speak, for Wasson has missed completely the *scale* of the sedimentation rate anomaly. Using calibrated radiocarbon dates (but with caution since very few datings have been done), Mohenjo-daro in the mature state may have existed for anything from 800 years to as little as two or three hundred. For the sake of this argument, I will use the maximum figure although other evidence suggests a shorter period. The date of the foundation of the city, which now extends from 11.6 metres below the present flood plain to a little more than 9 metres above it, can be put tentatively at 2600 B.C. Whatever caused the flooding, there should be little reasonable doubt (and the belief is supported by the samples analysed from within the raised part of the mound, which are practically indistinguishable from those taken from below flood plain level) that the total depth of sediment deposits was around 21 metres all achieved in a period of 800 (or less) years.

Wasson reasonably points to the need for a detailed investigation of the methods employed to calculate modern rates of accumulation, although they are acceptable to their present highly competent users. I frankly do not know how they were done but I would guess that they were based on the indications, during low winter flows, of clear signs in the cliff-like banks of the sites of various inundation canals : these could presumably often be identified from the literature (which extends back about 1500 years I would guess, anyway many centuries) and exactly datable. In the case of the Nile, I would guess that actual depth of silt cover accumulated between closely datable remains provided the evidence, but this is only a guess. The figures of 1.8 metres per thousand years from pre-partition India and of 1.37 metres per thousand years for the Nile seem to reflect the different characters of these rivers ; and the figures are comparable, when appropriately factored down for rivers subject to only sporadic short-term over-bank flooding, with the very much smaller aggradation rates typical of rivers that now rarely reach their flood plain level. I would have thought that these figures, certainly based on some kind of long-term historical/physical evidence could be accepted give or take 20%. If Wasson takes 20%, he would arrive at a figure of 2.16 metres per 1000 years. The presently estimated date of the lowest level of all would be around 2600 B.C. (calibrated) or 4600 years from to-day. This, assuming sedimentation continuing at more or less the same mean rate for the whole of the period, would result in deposition of some 9.9 metres (say 10 metres). But the present flood plain level alone at Mohenjo-daro accounts for 11.6 metres in at most 800 years (taking the longer "life" of the city) or 14.5 metres per 1000 years or 14.5 cms./annum. If it is conceded that the part of the site above present ground level was also covered in alluvium, involving a total depth of 21 metres, we arrive at the staggering rate of 26.25 metres per 1000 years or 26 cms. per annum (over 10 inches). The higher rate of aggradation would be practically visible to the naked eye at more than 2 cms. per month. And then, and herein lies the anomaly, no more sedimentation at all for the succeeding 3800 years, but instead, degradation of some 11 metres in that time.

To suggest seriously that this is what happened only during the occupation of the city, from fluviatile flooding, would verge on lunatic fringe, if the siltation rate anomaly were known to Wasson which it evidently is not. But that is not the whole story. If Wasson insists on fluviatile deposits of only the 11.6 metres necessary to reach the present flood plain, the level of the flood plain at the end of the city's life would have been about 1.73 metres above the city's lowest, earliest level. Why then should they proceed to build this city (which is in no sense a *tell*) to a height of 19.27 (21-1.73) metres above the flood plain, with great platforms of mud brick anything up to 5 metres high perched way up above any conceivable flood level ? The Indus flood plain is of the order of 45 kilometers, wide and, in order to leave any trace of flood deposit on the top levels of the site (which indeed exist), the flood would have had to be at least 20 metres deep involving a cross-sectional area of flow of the order of 9×10^5 square metres. If Wasson will concede a modest 2 metres/second average velocity of flow (it would have certainly been much more) a flood peak discharge of 1.8 million cubic metres per second would be involved.

I think Wasson will have to lift his gaze from a tunnelled look at sediments and recognize that there is an enormous anomaly quite inexplicable in either sedimentary or normal hydrological terms.

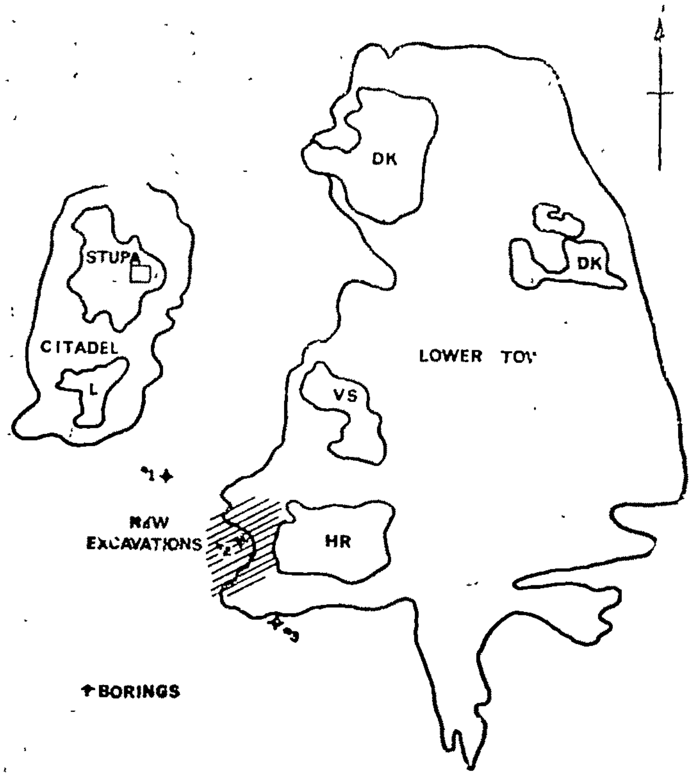
I have repeated at intervals over the last 20 years, ever since this colossal anomaly started bugging me, that this is the problem we are trying to solve. Nit-picking over grading analyses does not help solve this one little bit nor does it help to describe this central anomaly as "other arguments of a secondary kind (involving) the modern rates of sedimentation".

It is only too true that "if these deposits are fluviatile, then the differences between the estimated present rates of sedimentation and those calculated for the past, needs to be explained." Since Wasson appears to be a proponent of fluviatile flooding, it now seems up to him to explain a rate of fluviatile sedimentation that must have been nearly seven times the present rate for just a few hundred years, and after that episode *no more depositions* (fluviatile or other) for about 3800 years. Or, he can try a rate about 12 times the present rate followed by about 3800 years of flood plain lowering. If he tries that one, he will have the great figures of Indian irrigation rising from their graves to silence him, for they knew, and the present irrigation people know, that the flood plain is aggrading.

One way and another, Wasson seems to have made a fairly large sedimentary mountain out of a small archaeological molehill. This was a foreseeable consequence of overlooking that I was writing for archaeologists and cultural historians most of whom accept that I, as a hydrologist, know a reasonable amount about river behaviour without having to bore them with the details.

Finally, for the record, I must reject totally the allegation that I proposed a fault-produced dam. I mentioned the possibility only to reject it. Of course there is no sound evidence, either morphological or geophysical, for a fault near Sehwan. There is, however, plenty of very sound evidence of mud extrusions from formations of the same series as the ridge at Sehwan and of movement of the Baluchistan geosyncline. These, partly "lubricated" by neogene muds, have caused massive coastal uplift episodes, as well as continuing mud extrusions and "volcanoes" (see our earlier articles for details). The most recent was in 1945 at Pasni where accompanying an earthquake, not only did the coast rise 1.5 metres but also two mud cones formed in the Arabian Sea charted at the time by a Royal Indian Navy ship and subsequently washed away. Then there is the historically attested (by various British Officers, including a certain Lieut. Raikes—a relative at six or so generations remove of the Indian Political Service) case of Allah Bund, most easily explicable in terms of sub-alluvial tectonic activity—probably again extruded mud to judge by contemporary reports.

Finally, I doubt whether lacustrine micro-biological faunal evidence will show up because the filling of the impoundment would not only have been rapid but seasonally continuous; and if Wasson is really convinced that all can be explained by the normal behaviour of a big river it would cost far less money to study that normal behaviour than to carry out the sedimentological examination around Mohenjo-daro. But although I don't agree with Wasson, I would enthusiastically support such an examination—drilling to at least 20 meters around Mohenjo-daro itself and to at least 50 metres in the area explored by Nedeco a couple of kiometers to the south.



MOHENJO DARO

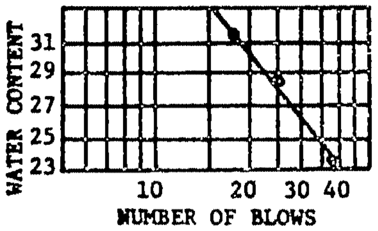
PLASTIC LIMIT

DETERMINATION NO.	1(only)
CONTAINER NO.	5
WT.CONTAINER + WET SOIL in gms.	22.60
WT. WATER in gms.	1.25
WATER CONTENT in %	19.9
WT. CONTAINER + DRY SOIL in gms.	21.35
WT.DRY SOIL in gms.	6.30
WT.CONTAINER in gms.	15.05

LIQUID LIMIT

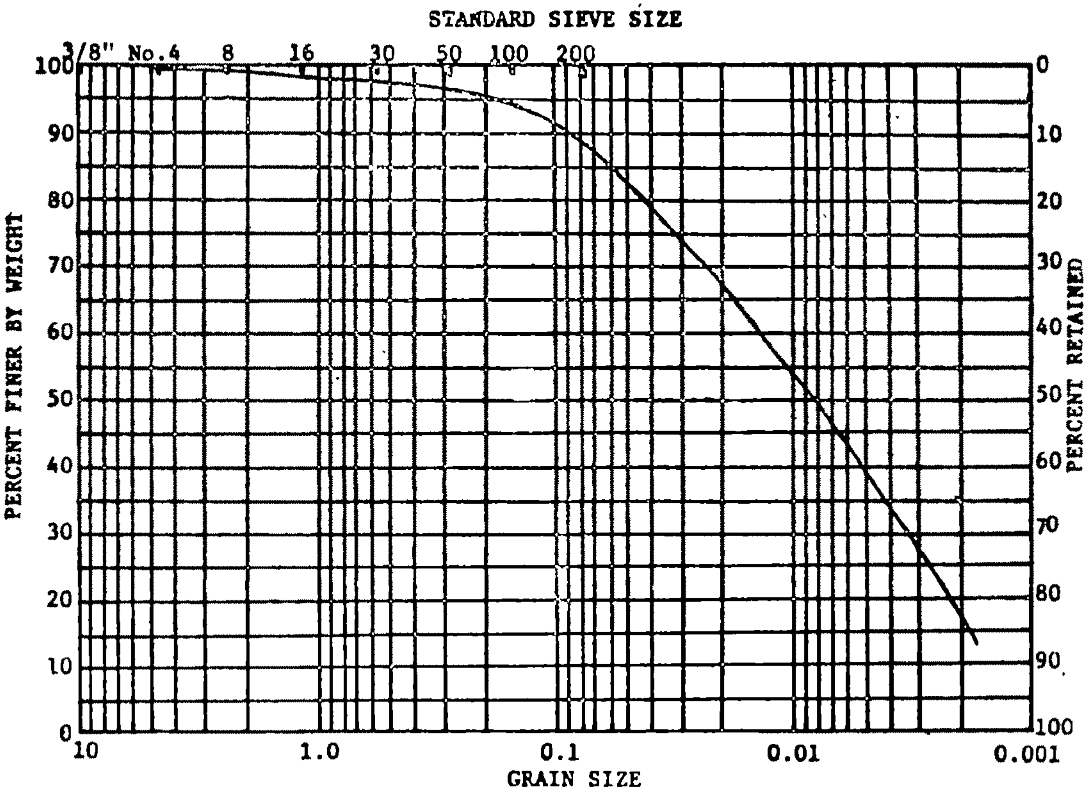
DETERMINATION NO.	1	2	3
NO. OF BLOWS	18	25	38
CONTAINER NO.	K	L	I
WT. CONTAINER + WET SOIL in gms.	19.32	20.25	20.61
WT. WATER in gms.	1.05	1.16	1.11
WATER CONTENT in %	31.5	28.7	23.1
WT. CONTAINER + DRY SOIL in gms.	18.27	19.07	19.50
WT.DRY SOIL in gms.	3.33	4.04	4.80
WT.CONTAINER in gms.	14.94	15.03	14.70

FLOW CURVE



RESULT SUMMARY

PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX
19.9	28.6	8.7



BORE HOLE NO. 1 SAMPLE NO. 6	INDUS VALLEY CONSTRUCTION CO.LTD.
DEPTH 20'0" to36'0" (6.1 to11.0 m)	LAHORE DATE :Feb.24,1965

Fig. 1

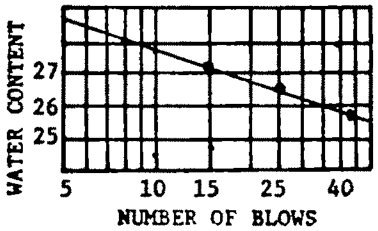
PLASTIC LIMIT

DETERMINATION NO.	1(only)
CONTAINER NO.	D
WT.CONTAINER + WET SOIL in gms.	24.69
WT. WATER in gms.	1.83
WATER CONTENT in %	19.6
WT. CONTAINER + DRY SOIL in gms.	22.85
WT.DRY SOIL in gms.	9.29
WT.CONTAINER in gms.	13.56

LIQUID LIMIT

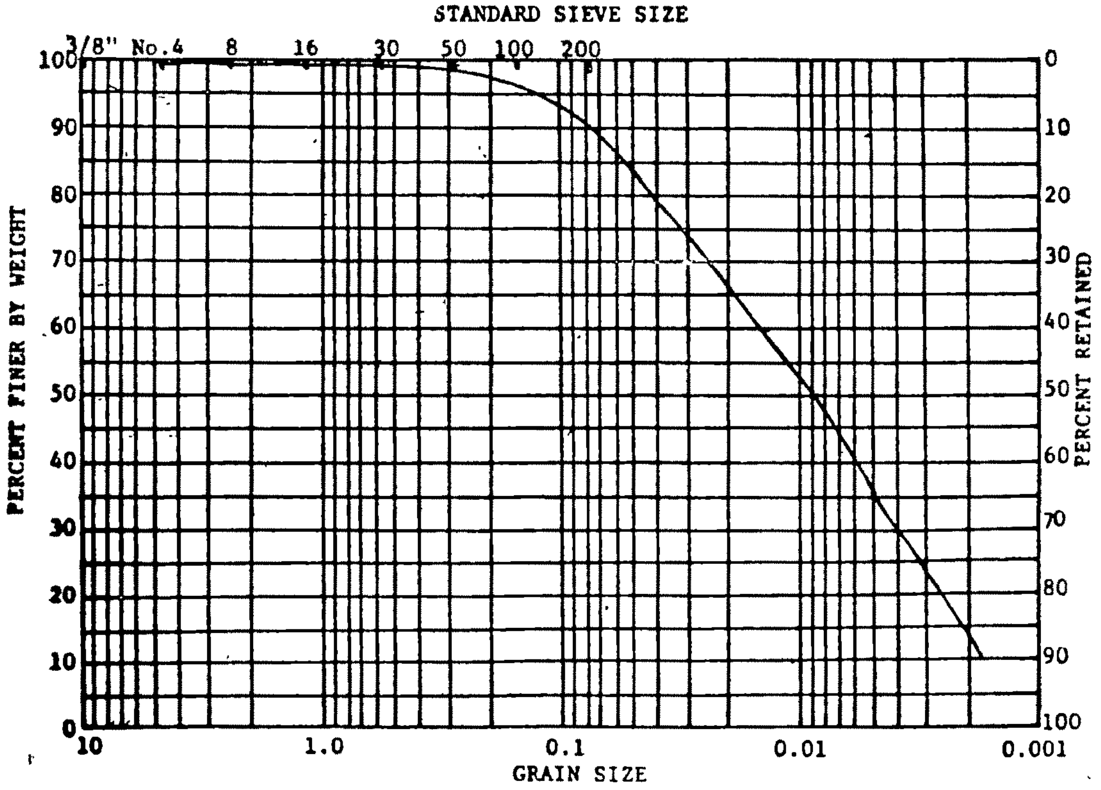
DETERMINATION NO.	1	2	3
NO. OF BLOWS	15	25	44
CONTAINER NO.	A	B	C
WT. CONTAINER + WET SOIL in gms.	22.55	23.76	21.36
WT. WATER in gms.	1.93	2.21	1.39
WATER CONTENT in %	27.2	26.8	25.6
WT. CONTAINER + DRY SOIL in gms.	20.62	21.55	19.77
WT.DRY SOIL in gms.	7.08	8.12	6.35
WT.CONTAINER in gms.	13.54	13.43	13.42

FLOW CURVE



RESULT SUMMARY

PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX
19.6	26.5	6.9



TOP OF HR AREA, NEW EXCAVATIONS	INDUS VALLEY CONSTRUCTION CO.LTD.
DEPTH BELOW SURFACE 7" (18 cms)	LAHORE DATE :Feb.24,1965

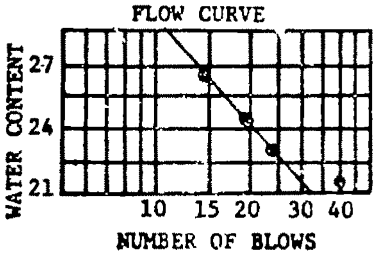
Fig. 2

PLASTIC LIMIT

DETERMINATION NO.	1(only)
CONTAINER NO.	E
WT.CONTAINER + WET SOIL in gms.	26.35
WT. WATER in gms.	1.89
WATER CONTENT in %	18.17
WT. CONTAINER + DRY SOIL in gms.	24.46
WT.DRY SOIL in gms.	10.46
WT.CONTAINER in gms.	14.00

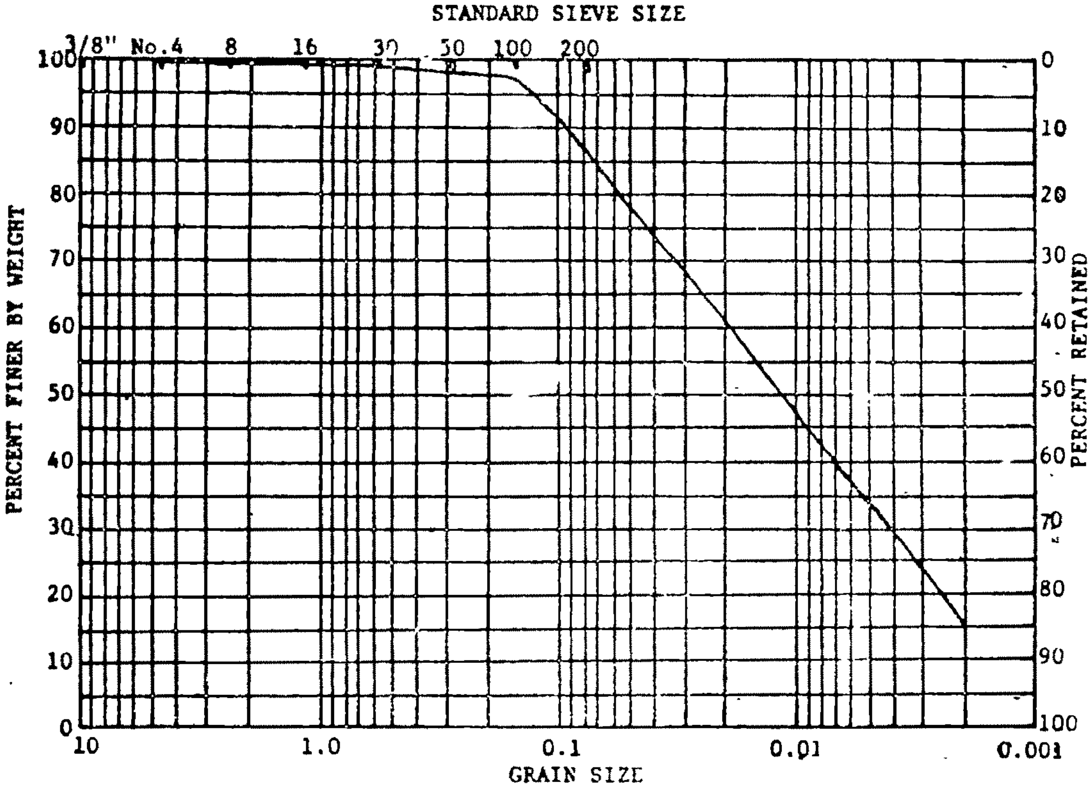
LIQUID LIMIT

DETERMINATION NO.	1	2	3	4
NO. OF BLOWS	15	20	24	40
CONTAINER NO.	A	B	C	D
WT. CONTAINER + WET SOIL in gms.	21.00	22.29	21.60	20.57
WT. WATER in gms.	1.57	1.74	1.53	1.25
WATER CONTENT in %	26.7	24.4	23.0	21.7
WT. CONTAINER + DRY SOIL in gms.	19.43	20.55	20.07	19.32
WT. DRY SOIL in gms	5.89	7.12	6.65	5.76
WT.CONTAINER in gms	13.54	13.43	13.42	13.56


FLOW CURVE

RESULT SUMMARY

PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX
18.1	23.2	5.1



BORE HOLE NO. 3 SAMPLE NO. 7	INDUS VALLEY CONSTRUCTION CO.LTD.
DEPTH 29'6" to 32'2"(9.0 to 9.8 m)	LAHORE DATE :Feb.24,1965

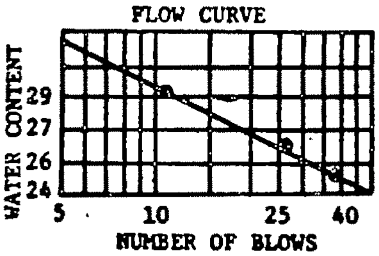
Fig. 3

PLASTIC LIMIT

DETERMINATION NO.	1(only)
CONTAINER NO.	I
WT.CONTAINER + WET SOIL in gms.	22.15
WT. WATER in gms.	1.40
WATER CONTENT in %	21.1
WT CONTAINER + DRY SOIL in gms.	20.75
WT.DRY SOIL in gms.	6.2
WT.CONTAINER in gms.	14.13

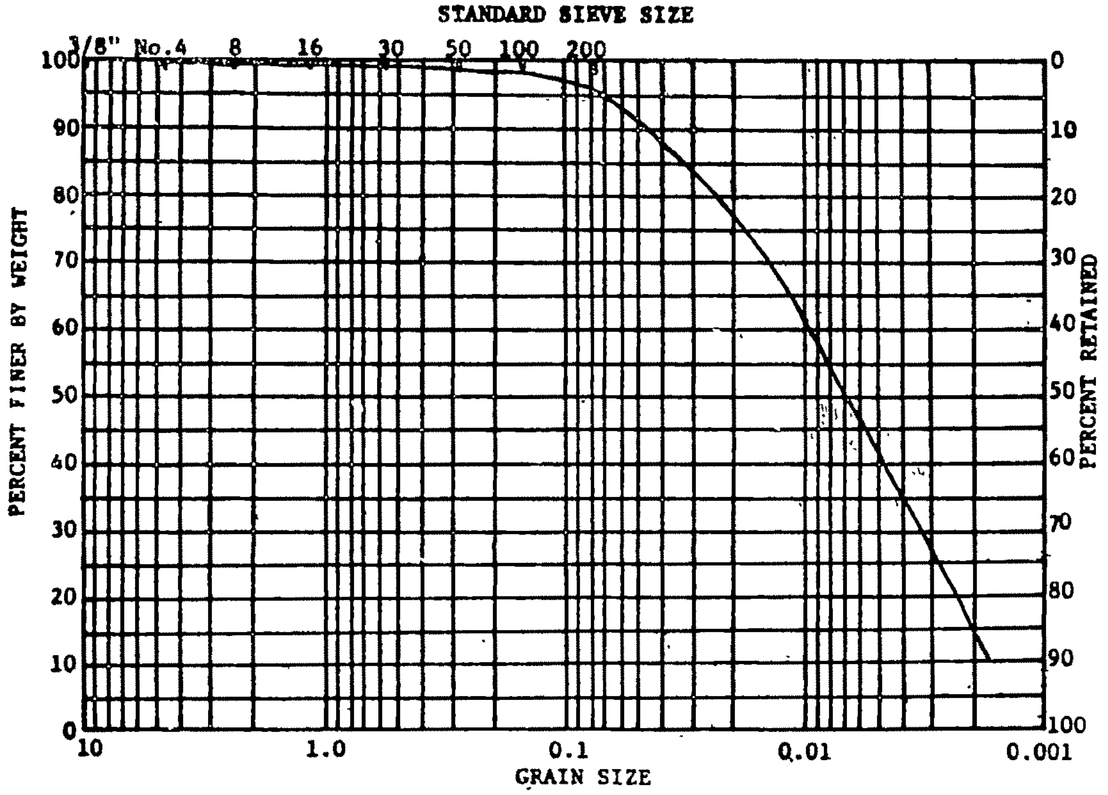
LIQUID LIMIT

DETERMINATION NO	1	2	3
NO. OF BLOWS	12	26	38
CONTAINER NO.	F	G	H
WT. CONTAINER + WET SOIL in gms.	20.57	20.96	20.43
WT. WATER in gms.	1.50	1.43	1.23
WATER CONTENT in %	29.6	26.3	24.1
WT. CONTAINER + DRY SOIL in gms.	19.07	19.53	19.20
WT.DRY SOIL in gms.	5.07	5.44	5.10
WT.CONTAINER in gms.	14.00	14.09	14.10



RESULT SUMMARY

PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX
21.1	26.1	5.0



BORE HOLE NO.1 SAMPLE NO. 5	INDUS VALLEY CONSTRUCTION CO.LTD.
DEPTH 16'4" to 20'0" (5.0 to 6.1 m)	LAHORE DATE :Feb.24,1965

Fig. 4

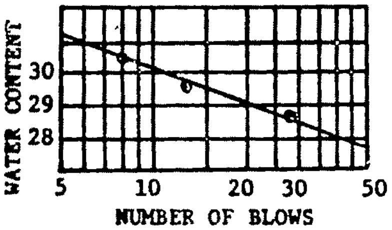
PLASTIC LIMIT

DETERMINATION NO.	1(only)
CONTAINER NO.	L
WT.CONTAINER + WET SOIL in gms.	23.07
WT. WATER in gms.	1.81
WATER CONTENT in %	25.4
WT. CONTAINER + DRY SOIL in gms.	21.26
WT.DRY SOIL in gms.	7.13
WT.CONTAINER in gms.	14.13

LIQUID LIMIT

DETERMINATION NO.	1	2	3
NO. OF BLOWS	8	13	28
CONTAINER NO.	E	F	H
WT. CONTAINER + WET SOIL in gms.	21.78	22.69	23.25
WT. WATER in gms.	1.83	1.99	2.05
WATER CONTENT in %	30.7	29.7	26.7
WT. CONTAINER + DRY SOIL in gms.	19.95	20.70	21.70
WT.DRY SOIL in gms.	5.95	6.70	7.10
WT.CONTAINER in gms.	14.00	14.00	14.10

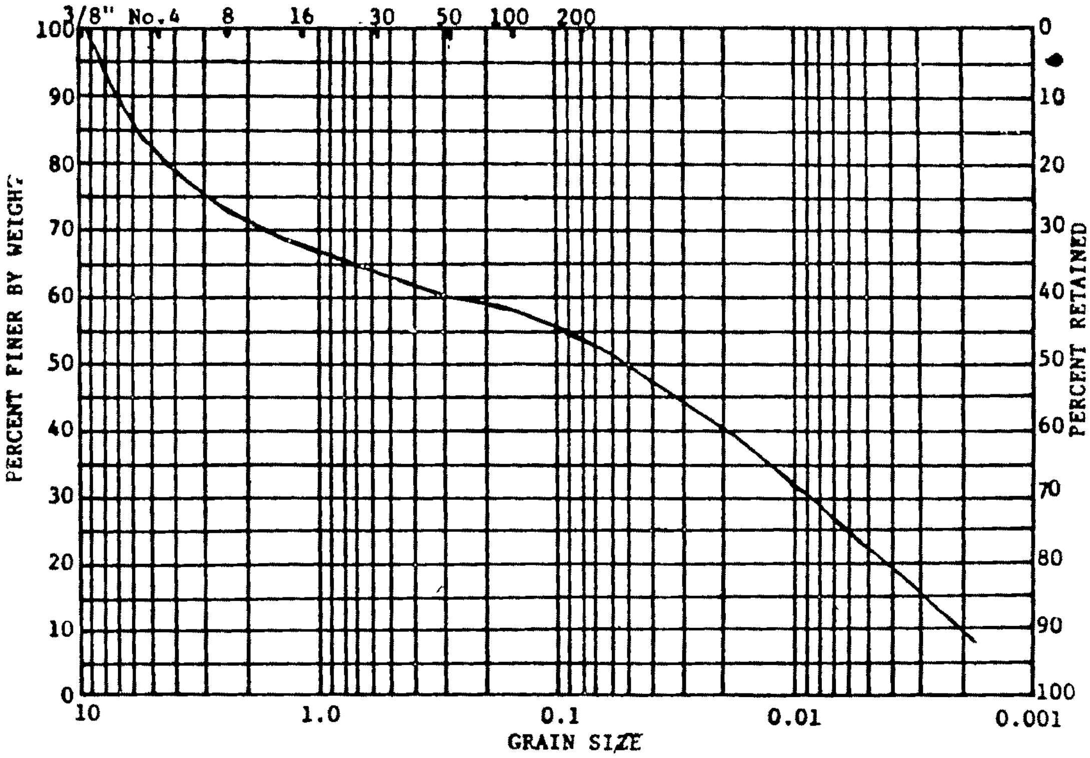
FLOW CURVE



RESULT SUMMARY

PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX
25.4	28.7	3.3

STANDARD SIEVE SIZE



BORE HOLE NO. 1 SAMPLE NO. 4	INDUS VALLEY CONSTRUCTION CO.LTD.
DEPTH 11'7" to 16'4"(3.5 to 5.0 m)	LAHORE DATE :Feb.24.1965

Fig. 5

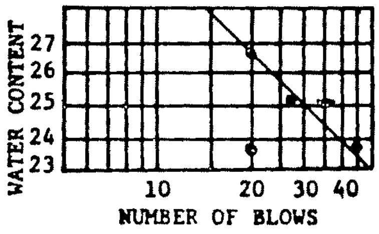
PLASTIC LIMIT

DETERMINATION NO.	1(only)
CONTAINER NO.	12
WT.CONTAINER + WET SOIL in gms.	23.88
WT. WATER in gms.	1.40
WATER CONTENT in %	18.0
WT. CONTAINER + DRY SOIL in gms.	22.48
WT.DRY SOIL in gms.	7.73
WT.CONTAINER in gms.	14.75

LIQUID LIMIT

DETERMINATION NO.	1	2	3
NO. OF BLOWS	20	28	45
CONTAINER NO.	7	9	11
WT. CONTAINER + WET SOIL in gms.	22.95	22.97	22.32
WT. WATER in gms.	1.75	1.54	1.41
WATER CONTENT in %	26.7	25.2	23.9
WT. CONTAINER + DRY SOIL in gms.	21.20	21.43	20.91
WT.DRY SOIL in gms.	6.56	6.12	5.91
WT.CONTAINER in gms.	14.64	15.31	15.00

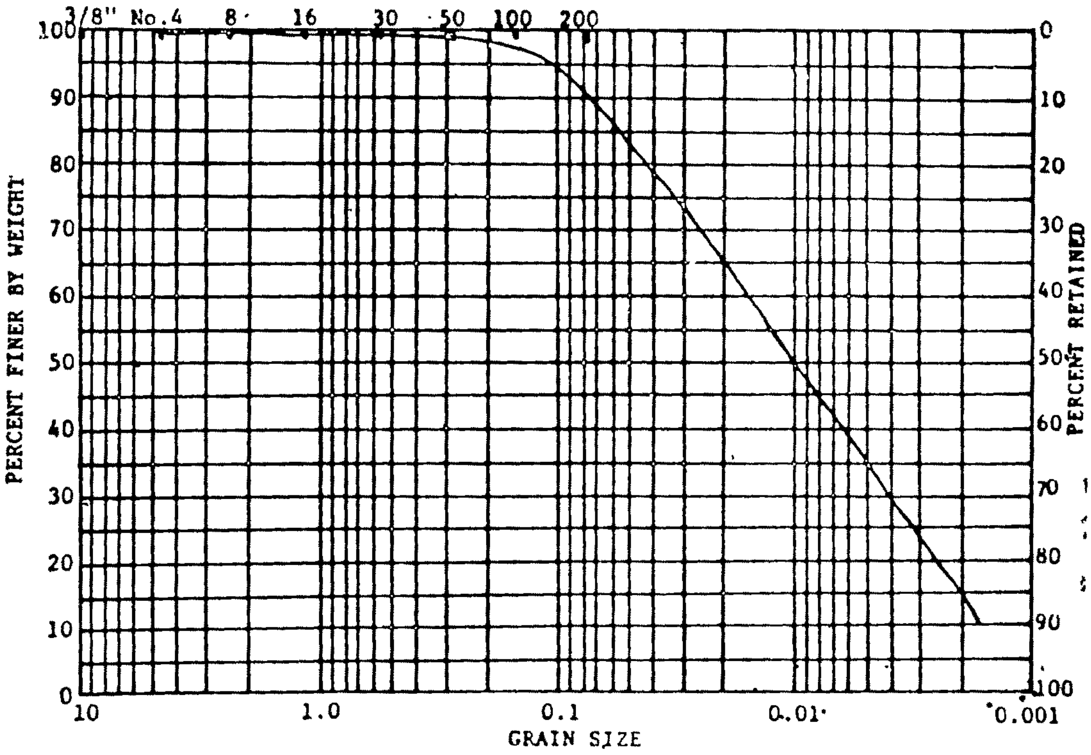
FLOW CURVE



RESULT SUMMARY

PLASTIC LIMIT	LIQUID LIMIT	PLASTICITY INDEX
18.0	25.7	7.7

STANDARD SIEVE SIZE



TOP OF HR AREA, NEW EXCAVATIONS	INDUS VALLEY CONSTRUCTION CO.LTD.
DEPTH BELOW SURFACE 8" (20.3 cms)	LAHORE DATE :Feb.24.1965

Fig. 6

NOTES

1. Using Wasson's grade scale: As he surmises, the use of M. I. T. scale makes virtually no difference with silt and clay combined. The M. I. T. upper limit for coarse clay is 0.002 mm. compared with Wasson's 0.0039 mm.

2. The Atterberg limits tests put the material in all cases very near the dividing line between clay and silt of low or medium plasticity/compressibility : normal field engineer's tests such as "dilation" and rolling out a thread indicate the definite presence of silt.

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Retrieval and Interpretation of Plant Remains from Archaeological Sites

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INTRODUCTION

The study of vegetal remains recovered from archaeological sites is a relatively recent development as a scientific discipline. In fact, it is one of the main goals of modern archaeology to reconstruct the past life ways and subsistence practices. The archaeobotanical studies are of great importance to prehistorians, archaeologists and biologists The prehistorians and archaeologists reconstruct the past history of a particular culture. The biologists add to the knowledge on the plants and animals associated with the ancient man. We are now in a position to provide sufficient knowledge regarding the wild plants domesticated, the time and place of their domestication and also the information about the wild progenitors of the present day cultivated plants. For a cytogeneticist and plant breeder, archaeobotany provides information on the germ plasm and factual history of evolution of crop plants. The study of carbonized grains and seeds gives an indication of the type of agriculture practised. The study also reveals whether crops were grown mixed, or were heavily infested with weeds or were relatively pure and uncontaminated. They also indicate the importance of wild plants as supplements in diet and give some indication of the relative importance of the balance between cereal crops, pulses and oil seeds in the agricultural system. Wealth of new information about the former environment and vegetation of various areas has also been brought out by archaeologists in collaboration with palaeobotanists, geomorphologists and geologists. Thus, the method of collecting the samples or carbonized grains, seeds etc. is of prime importance in evaluating the amount of information which can be obtained from them.

The archaeologists and the palaeoethnobotanists have been facing the problem of recovering the materials of botanical interest from the archaeological sites right from the time such studies were begun. The retrieval methods started with the 'hand-picking' of the charred plant remains from the soil samples collected from the various periods and strata of the archaeological sites. But, this technique proved to be very inefficient as one could only pick up the materials if they occurred in sizes and concentrations large enough to attract attention during excavation. Then the practice of using mesh screens of various sizes started. Again, these mesh screens were not adequate enough to recover the full size range of debris and quantities of small food remains usually slipped unnoticed through the mesh screens. Thus the urgency for developing efficient tecnniques of recovering food remains—large and small, increased. "Flotation revolution" in archaeology has greatly increased our ability to recover seeds and other carbonized plant materials from archaeological sites.

The paper deals with the various versions of flotation set-ups that have been developed during last two decades and also their application for the retrieval of materials from two sites of Kashmir.

Flotation Technique

Stuart Struever (1968) outlined the procedures and equipment necessary for applying a simple flotation technique using both water and chemical flotation procedures.

The principle involved in the water separation technique is that different substances, for example, stone, burnt clay, bones and plant remains have different porosites and hence different densities. Therefore, they settle in water at different rates. Using this principle, bones and carbonized plant remains can be separated from the soil.

Samples are gently poured into a wash tub whose bottom has been replaced with a fine mesh screen. The bottom of the tub is submerged about 1 inch below the surface of water. As the soil is poured in the tub, it is gently rotated in alternating clockwise and counter-clockwise directions, allowing the fine grained silts and sand to escape. Within a few minutes only the bone fragments and plant matter remains which are scooped off with a tea strainer and placed on thick pads of newspaper and dried in shade.

This technique generated some of its own methodological and theoretical problems. Thus depending upon individual site strategies various workers modified the the original procedure as follows :

Helbaek (1969) used a simple hand system to float the Ali Kosh deposits. The dried soil is poured in a basin with water. Under cautions stirring, the water is slowly poured through a fine mesh sieve, the plant matter floats on the surface and is retained on the sieve.

David French (1971) developed a machine aided water sieving technique for the prehistoric site of Can Hasan in Turkey. The system uses a pump to fill the storage tanks from which water flows through a main box to a float box where flotation is accomplished. Weaver (1971) at the Middle East Technical University in Ankara elaborated the French's set up to develop the so called "Ankara Machine". In this model the sludge from the main box and the overflow from the float box are directed into an "Elutriator" which is meant to recover tiny seeds and other small remains between 0.1 mm to 1 mm size ran ge.

Jarman, Legge and Charles (1972) have used the froth flotation technique. Here the detergent and paraffin are added to the water into which sample is put.

A number of versions of "Machine aided flotation" have been used by various workers. Lapinskas (1974) has made the incorporation of a sieve inside the drum to improve the efficiency of recovery and pre-treatment of samples with high clay content with 'Calgon' to aid disaggregation. Watson (1974) used Garbage Cane or Oil Drum technique for the salt cave sediments. It is simple and effective and relatively large quantities of deposits can be processed if the deposit is sandy. Limp (1974) devised the Indians Machine which embodies two improvements over the Ankara set up ; a baffle or sloping base to facilitate desludging and an inflow mechanism that directs water under pressure at the bottom of the heavy fraction.

Wolynee and Mertz (1968) and Schock (1971) devised an acceptable indoor flotation technique for retrieval of archaeological remains in the laboratory.

Chemical Flotation

For separating animal bones and carbonized plant remains, chemical flotation technique is used. Dr. Laurence Nobles developed this technique in which Zinc chloride solution with a specific gravity of 1.62 is used. It is prepared by dissolving 860 gms of $ZnCl_2$ in water to make one litre of solution (7.1 lbs of $ZnCl_2$ used to make 1 gallon of solution). When the light fraction is poured into the $ZnCl_2$ solution, the plant materials float while the bones etc. sink. By using this process almost 100% separation of the two is obtained, (Struever, 1968).

Helbeck (1969) used carbon tetrachloride rather than water, as CCl_4 is 1.8 times as heavy as water and so accentuates the buoyancy of charcoal. However, CCl_4 is highly volatile and thus impracticable.

Lange and Carty (1975) suggested the use of salt water particularly for the sites near the Oceans. Jarman, Legge and Charles (1972) while commenting upon the application of salt water technique stated that sodium chloride leaves a white encrustation on plant remains, thus making the identification more difficult. It is advised

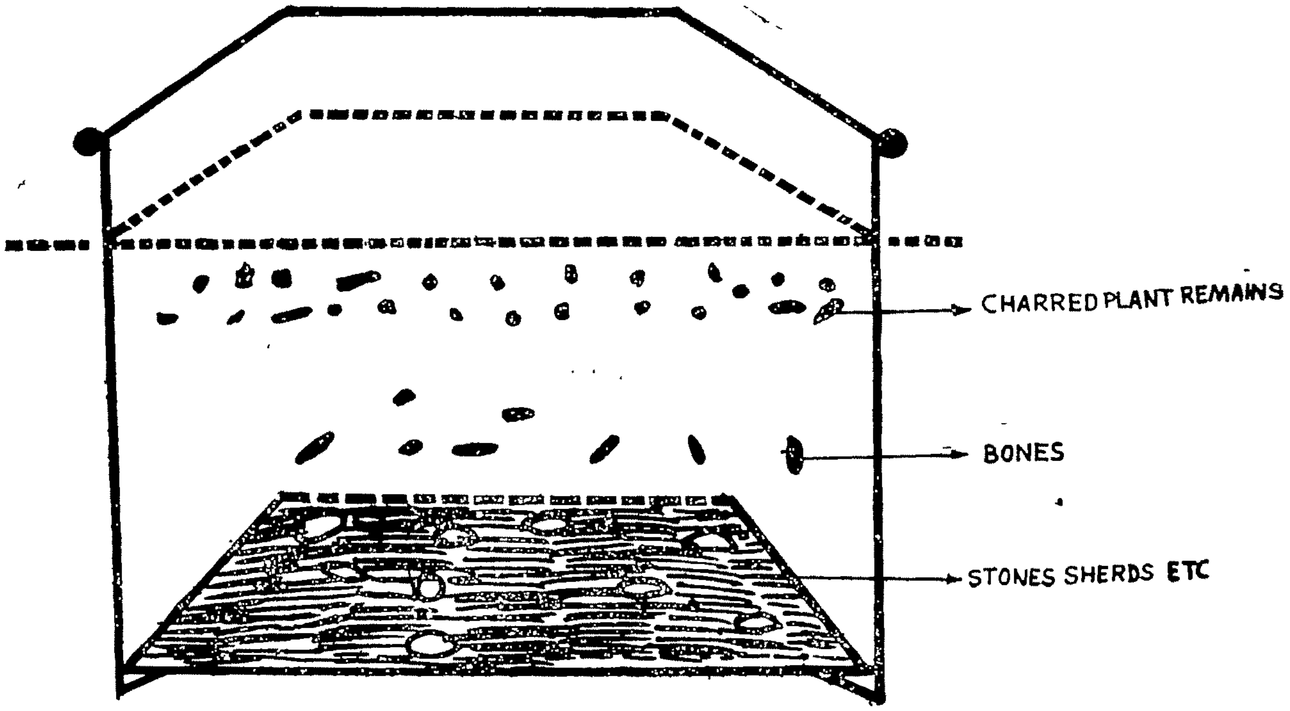
CHARRED PLANT REMAINS
BONES
STONES SHERDS ETC

DIAGRAM ILLUSTRATING PRINCIPLE OF
WATER SEPARATION.

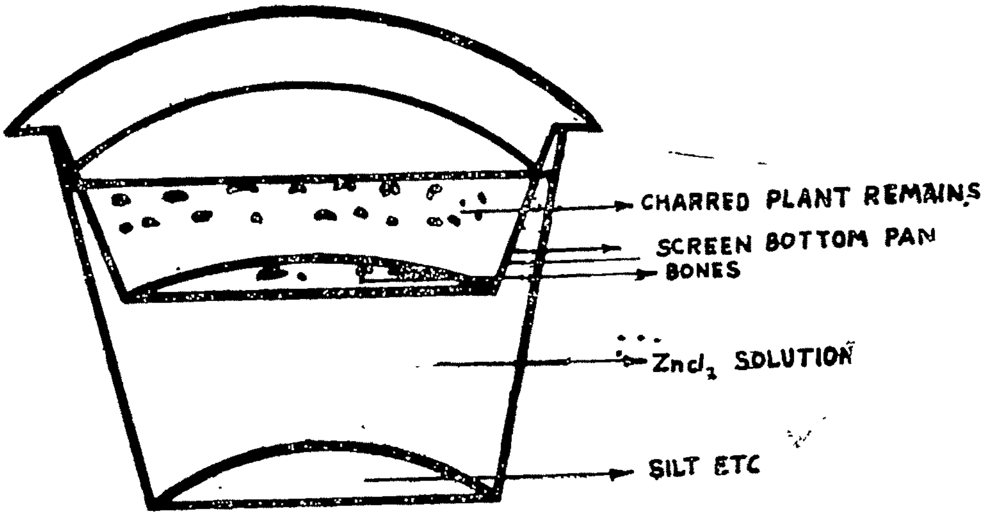
CHARRED PLANT REMAINS
SCREEN BOTTOM PAN
BONES
$ZnCl_2$ SOLUTION
SILT ETC

DIAGRAM ILLUSTRATING PRINCIPLE OF
CHEMICAL FLOTATION.

that the remains must be thoroughly rinsed at the time of processing. But this increases risk of damage of the sample and also requires large amounts of clean water to which the salt water separation is used as an alternative.

Lange and Carty (1975) reported that possibility exists that preservation of delicate bones and vegetal remains is enhanced by salt water immersion. But Helbe ck speaks strongly against the use of salt and according to him this has deleterious effects on the carbonized plant material.

Reliability of Flotation Techniques

The cost effectiveness of various methods used to recover macroscopic organic remains from archaeological deposits varies widely depending upon the sample type, environment of the site etc. (Keeley, 1978). Wagner (1982) suggested the poppy seed recovery test for determining the effectiveness and consistency of any particular botanical flotation system. By adding a known number of charred poppy seeds (*Papaver somniferum*) to a sample before it is processed, archaeobotanist can check for loss, damage and intersample contamination. Different systems, equipment method etc. yielded recovery rate percentage ranging from 6% to 98%. Such percentages provide a basis for comparison among widely differing flotation systems and enable the archaeologists to decide which floatation system to use under particular logistical conditions.

Munson (1981) recommended the use of carburator screen for making reliable recovery of smaller seeds. Schaaf (1981) proposed a method for sub-sampling large archaeological features for flotation purposes so that sub-sample will be a reliable representation of the total.

Vander Veen and Fieller (1982) considered three fundamental procedures for selecting samples of carbonized plant material namely "Spoon", "Sample spiltter" or "riffle box" and "grid" methods. In the spoon method the carbonized plant material is mixed thoroughly and then one or more spoonfuls of it are taken. A "sample splitter" or "riffle box" mechanically divides the sample into two equal parts. In the "grid" method sample is spread on gridded paper and grid squares are selected at random to achieve the sub-sample of desired size. The riffled method showed the most consistently reliable results.

Retrieval of Materials From Kashmir Sites

While recovering the materials from two important sites-Burzahom and Semthan it was found that methods applied elsewhere are not applicable to Kashmir sites. As the soil moisture content is very high, the flotation becomes possible only after the soil is completely dried off the moisture. Furthermore the state of preservation is not as good as elsewhere. The materials are very fragile and especially the charcoal pieces usually break when flotation was carried out. Thus form of the material and other characteristic features are lost. In order to retrieve maximum materials following methods were used.

(1) *Hand Picking*: The samples were spread on a sheet of paper and the larger materials were picked with the help of forceps.

(2) *Sieving*: After hand picking, the soils were screened through mesh screens of various sizes to recover quite a large size range of grains and charcoals.

(3) *Flotation*: In order to recover the smaller seeds, which could not be retrieved through mesh screens, the soil samples were subjected to flotation. A simplified version of flotation technique developed by Struver (1968) was used. The dried soil samples were poured in a tub of water under constant stirring. The plant remains that floated on the surface were scooped off with the help of a strainer.

Using these procedures, a fairly good amount of interesting materials were recovered.

In India, since little work has been done in this field, the scattered information collected so far does not mention the exact method of retrieval. It is suggested that the methodology adopted during the investigation of plant remains should be mentioned in the research papers.

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Quaternary Coastal Sediments and Stratigraphy, Southeast India

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ABSTRACT

Examination of a formerly little studied area in southeast India has revealed a wealth of late Quaternary coastal deposits, extending upto 24 km inland. Fossil marine sediments from reef, nearshore high energy, and lagoonal environments are found at both 15 to 18 m above present mean sea level (Ovari Series) and at 6 to 9 m asl (Idindakarai Series). Most of these sediments have been cemented, following deposition, by low-Mg calcite under subaerial conditions. Some of the marine sediments are overlain by carbonate-cemented dune sands (aeolianite; Kanya Kumari Series) which are typically capped by a massive calcrete with embedded landsnails (Poochikkadu Series) dated to 20-25,000 years BP. All of these earlier sediments are overlain and 'infilled' by aeolian sands, weathered subaerially to a deep red colour following the liberation of iron oxides, kaolinite and illite. Mid-Holocene marine deposits abut on the seaward margin of the Pleistocene sediments, taking the form of raised (up to 3 m asl) corals, high energy nearshore deposits, and lagoonal sands, silts and clays. Cementation to varying degrees by low-Mg calcite is observed within them. Modern beaches, dunes and lagoons fringe the present shore.

INTRODUCTION

Much of the Indian Subcontinent remains undocumented in terms of Quaternary sediments and environmental changes. The earliest detailed work dates from the Geological Survey of India between 1850 and 1930. Since then coastal areas that have received particular attention include N.W. India (Allchin, Goudie and Hegde team, 1971, 1972, 1973 ; Gupta, 1973 ; Sperling and Goudie, 1975; papers in Agrawal and Pande, 1977), Maharashtra coast (Guzder, 1975), sediments offshore from the Kerala coast (Marchig, 1972; Mattiat et. al., 1973 ; Zobel 1973 ; Von Stackelburg, 1972; Gopinatham and Qasim, 1974) and from parts of the east coast (Rao, 1958, 1960, 1964).

The sedimentary deposits in the southern tip of India, south of latitude 13°N have received limited attention, even though there is one area particularly rich in Quaternary deposits (Figure 1). This lies between Rameshwaram (8°17'N, 79°19'E) and Kanya Kumari (9°5'N, 77°33'E.) To the North of this area there are the widespread deposits of the Cauvery delta, whereas on the west coast laterites and Tertiary beds form a cliffed shoreline and large mud banks have developed offshore. This paper documents the sediments in the southeastern area. After reviewing, briefly, the relevant literature, the major stratigraphic units in the coastal sequence are

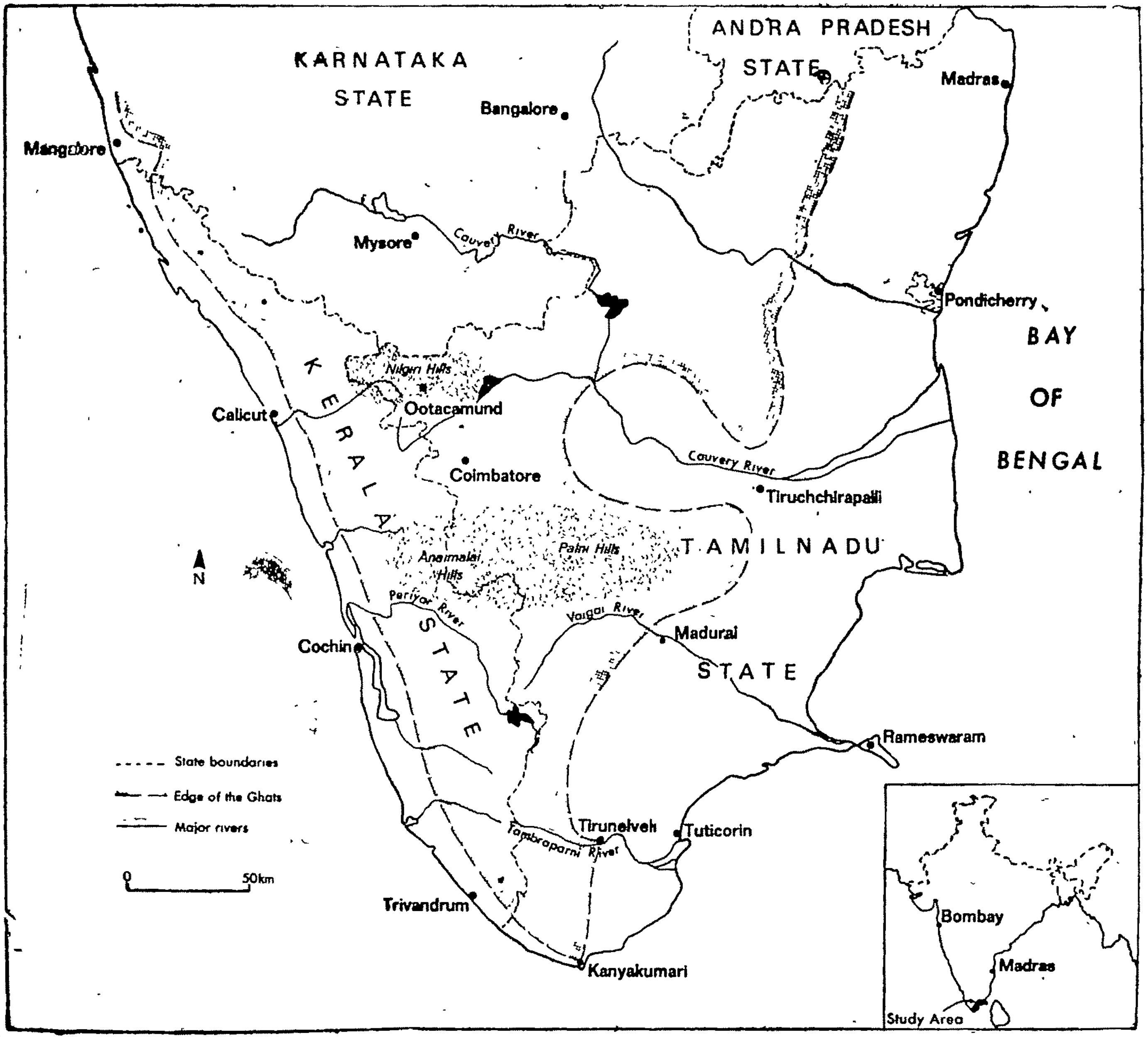

ANDRA PRADESH STATE
KARNATAKA STATE
Bangalore
Madras
Mangalore
Mysore
Cauvery River
Pondicherry
BAY OF BENGAL
KERALA STATE
Nilgiri Hills
Ootacamund
Calicut
Coimbatore
Cauvery River
Tiruchchirapalli
TAMILNADU STATE
Anaimalai Hills
Palni Hills
N
Periyar River
Vaigai River
Madurai
Cochin
Rameswaram
State boundaries
Edge of the Ghats
Major rivers
0
50km
Tirunelveli
Tuticorin
Tambraparni River
Trivandrum
Kanyakumari
Bombay
Madras
Study Area

Fig. 1.

described within a chronological framework. The implications of these studies in reconstructing late Quaternary environmental changes are the subject of a further paper. Additional details about the stratigraphy and environmental reconstruction are given in Gardner (1981a).

The Area

The sediments lie on the seaward edge of eastern coastal plain of south India. The plain descends from the Ghats mountains occupying the central and western parts of the Peninsula, and most of it lies less than 150m above sea level. It is covered with a thin veneer of lateritic gravel and alluvium and is disected by several major rivers flowing in shallow valleys. The river regime is highly seasonal ; the higher flows occur in late summer and autumn and flooding often takes place in November and December.

The plain is composed of a suite of Archaean (Pre-Cambrian) igneous and metamorphic rocks (Wadia, 1957; Subramaniam, 1967) that includes granites, granulites, gneisses and charnockites. The mineralogy is highly variable but a notable feature of the granulite facies is the high content of sillimanite, whereas the charnockites in general are relatively rich in garnet, magnetite, ilmenite and pyroxenes. On the drier eastern parts of the plain these rocks support red earth soils (Murali et al., 1974), rich in kaolinite and hematite, with black hydromorphic colluvial counterparts formed in poorly drained depressions. The Quaternary deposits, which fringe the modern shoreline and extend up to 20 km inland overlie the Archaean basement rocks (Figure 2).

This part of India receives its rainfall mostly during October and November, and not in the summer as in most of India. This is because it lies in the rainshadow of the Ghats mountains (Blasco and Legris, 1973). The area thus receives the strong westerly and southwesterly winds characteristic of the summer Monsoon, without receiving the rain. The rain falling in October and November is associated with tropical cyclones over the Bay of Bengal, which form as the Monsoon retreats southwards from India. This retreat is characterised by a weakening of the westerly winds and the onset of a northeasterly wind pattern. However, the extreme southeast is even afforded some protection from the tropical cyclones by Sri Lanka. As a result, the field area receives

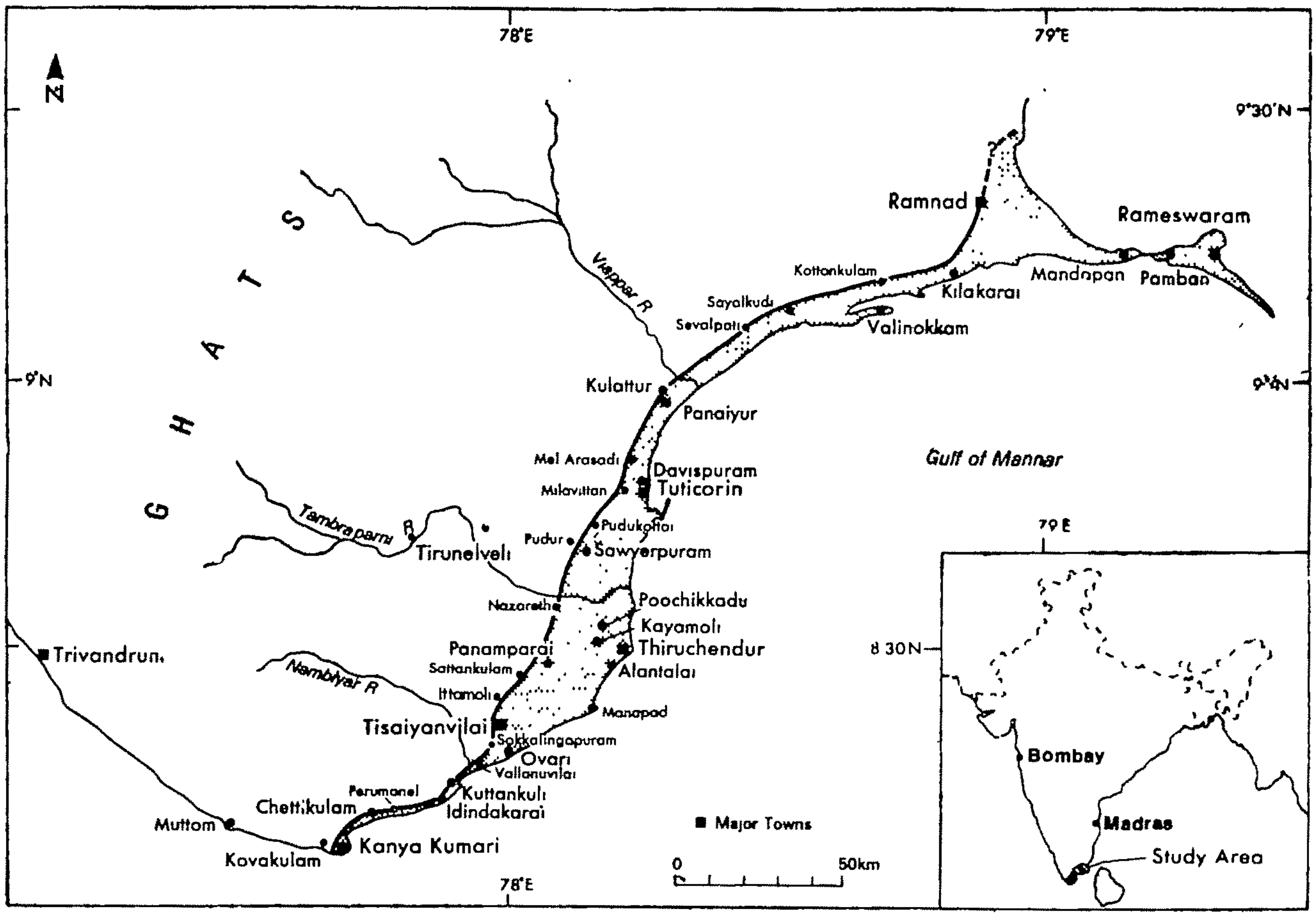

78°E
79°E
N
9°30'N
9°N
8 30N
GHATS
Vaippar R
Tambraparni R
Nambiyar R
Ramnad
Rameswaram
Kottankulam
Mandapan
Pamban
Kilakarai
Sayalkudi
Sevalpatti
Valinokkam
Kulattur
Panaiyur
Gulf of Mannar
Mel Arasadi
Milavittan
Davispuram
Tuticorin
Pudukottai
Pudur
Tirunelveli
Sawyerpuram
Nazareth
Poochikkadu
Kayamoli
Thiruchendur
Alantalai
Panamparai
Sattankulam
Ittamoli
Manapad
Tisaiyanvilai
Sokkalingapuram
Ovari
Vallanuvilai
Perumanal
Kuttankuli
Idindakarai
Chettikulam
Muttom
Kovakulam
Kanya Kumari
Trivandrum
■ Major Towns
0
50km
79 E
Bombay
Madras
Study Area

Fig. 2.

one of the lowest, and often less predictable rainfalls in the Peninsula. Details of the meteorological records for Pamban and Tuticorin are given in Table 1. In these areas of low and highly seasonal rainfall the dominant natural vegetation type is the *Acacia* species. *Ipomoea*, *Spinifex*, *Hibiscus* and *Pandanus* species are also found in the sandy coastal areas, as are the cultivated Palmyra palm and cashew-nut.

TABLE 1

Month	*Mean daily air temperature Max.°C*	*min.°C*	*Relative humidity (%)*	*Monthly rainfall (mm)*	*Wind speed (km. p.h)*	*Major wind directions*
Pamban (1931-1960)						
Jan.	28.0	24.0	81	66.3	18.5	N; NE
Feb.	29.1	24.1	77	18.5	13.9	N; NE; E
Mar.	30.8	25.1	76	23.9	11.2	N; NE; SE
Apr.	32.2	26.7	77	68.4	12.1	SE; S
May	32.6	27.5	77	24.0	18.0	SE; S; SW
Jun.	31.9	27.1	77	5.5	20.3	S; SW
Jul.	31.5	26.5	77	8.7	16.6	S; SW; W
Aug.	31.5	26.4	77	12.0	15.6	SE; S; SW
Sep.	31.3	26.3	78	15.8	15.8	SE; S; SW
Oct.	30.7	25.6	81	175.3	13.1	S; SW
Nov.	29.3	24.7	83	308.1	14.9	N; NE; NW
Dec.	28.0	24.0	84	196.4	19.0	N; NE; NW
	30.6	25.7	79	922.9	15.7	annual total/ mean
Tuticorin (1955-1960)						
Jan.	27.6	22.3	77	16.5	22.3	no data available on wind directions
Feb.	28.2	23.0	75	20.4	19.4	
Mar.	29.7	24.9	74	29.6	16.4	
Apr.	31.9	26.5	74	65.4	13.6	
May	34.3	26.9	66	37.2	13.9	
Jun.	35.5	26.8	60	4.9	18.2	
Jul.	34.4	26.5	58	10.4	19.7	
Aug.	34.5	26.3	57	5.0	19.2	
Sep.	33.9	26.0	59	7.5	16.7	
Oct.	31.9	25.1	69	122.8	12.3	
Nov.	29.1	23.8	81	193.9	13.8	
Dec.	27.8	22.6	78	100.9	20.0	
	31.6	25.1	69	614.5	17.1	annual total/ mean

Previous Studies

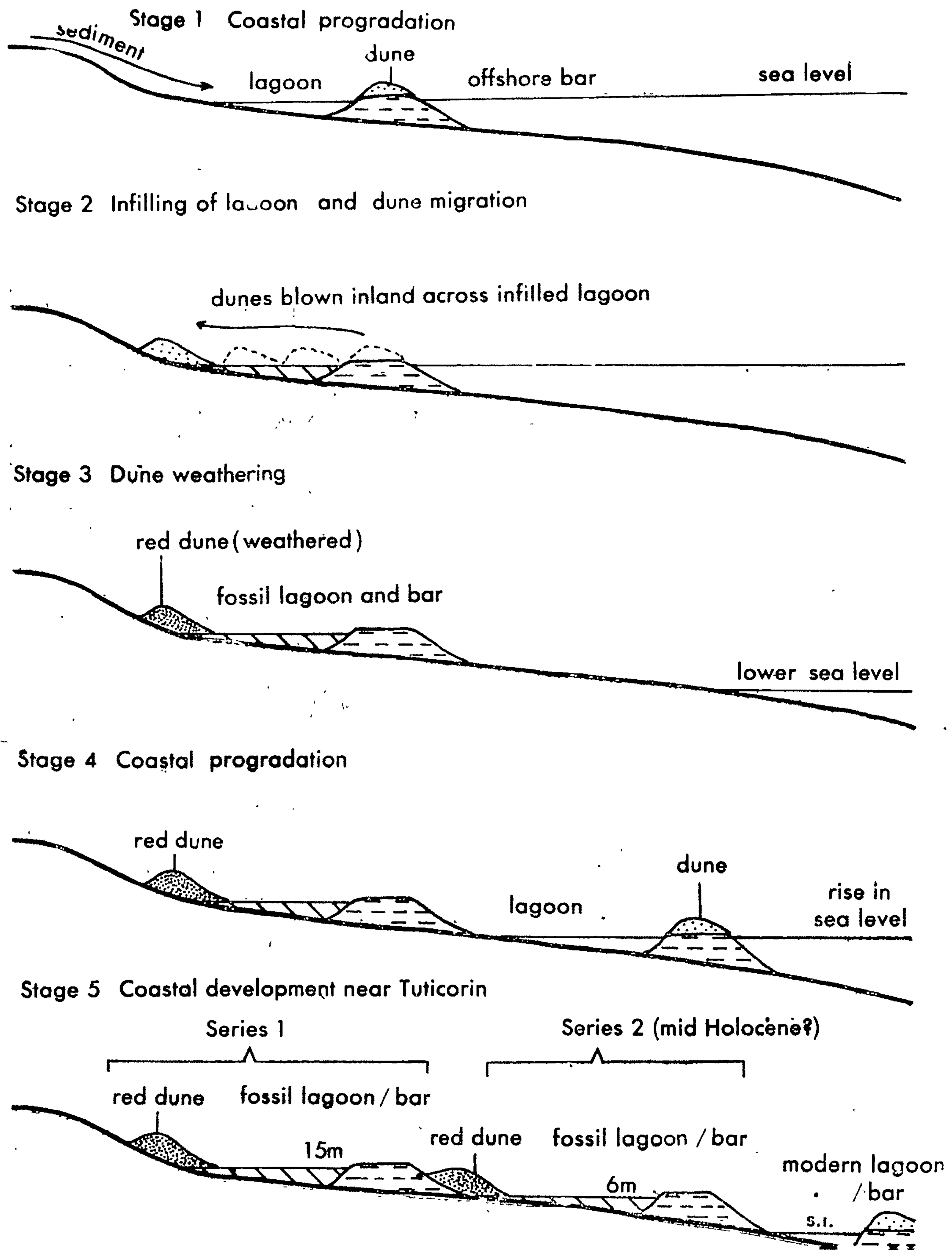
There have been few studies in this part of India. The earliest and most comprehensive, by Foote (1883), provided virtually the sole contribution of any value to the study of coastal historical geology until the work of Zeuner and Allchin (1956). Foote identified (marine 'sub-recent calcareous grits' over much of the field area, and extending in places to 60 m above present sea level. In addition he classified two types of aeolian deposit, namely red and white dunes ; the white were found along the modern shoreline, whereas the red dunes (termed teri locally) were found inland in large patches overlying the marine calcareous grits. Foote ascribed the red colour to the coating of clay and ferric oxide on quartz grains and in the matrix. He thought the red sediment was derived detritally from the red earths of the Ghats as a result of aeolian activity during the southwesterly Monsoon (as described in Gardner, 1981b). Foote also identified raised corals around Rameswaram, alluvial deposits associated with the rivers, and an older marine formation to which the assigned a Tertiary age on the basis of correlation with the laterite-capped Warkalli Formation of the southwest coast.

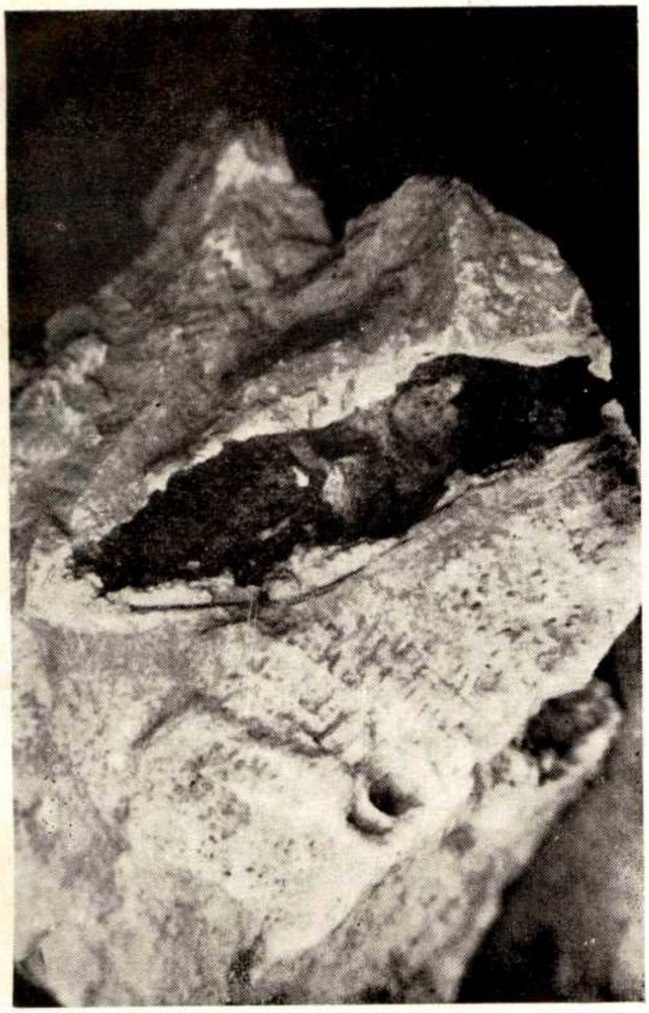
Much of Foote's work was reiterated by Dowie (1940) and Kalyanasundaram (1943). Aiyappan (1945) expressed the view that the teris and associated deposits were evidence for progressive desiccation, but his main contribution was in the study of microliths found on the teri sands at Sawyerpuram. A classification of the teri sands based on their morphology appeared in 1950 (Menon). Tipper (1931), however, was the first and only person to study the mineralogy of the teris. He identified ilmenite, magnetite and monazite in white dunes on the southwest coast and inferred that localised decomposition of the minerals within the red dunes may have provided additional matrix. This line of argument was developed by Zeuner and Allchin (1956), who proposed an interpretation of Quaternary coastal-evolution for the area. Based on fieldwork in the Tuticorin area, they explained the development of the coastline in terms of successive phases of lagoon and dune formation, and weathering as shown in Figure 3. These phases were thought to be recorded as morphological 'steps' in the landscape. They argued that coastal outgrowth led to the formation of a lagoon fringed by dunes on the seaward barrier. The lagoon was infilled and the dunes migrated over its surface to the landward edge, where migration was halted by a rise in the topography. The weathering of the dune sand took place *in situ*, corresponding with a drop in sea level, or negative oscillation. The cycle commences again with the formation of a new lagoon at a lower sea level. Zeuner and Allchin thought that this cycle of accretion had taken place twice in the history of the coastline, and had resulted in raised lagoon deposits and reddened dunes at about 15 m and 6 m above present sea level. Dating of the levels proved difficult, however, a postglacial age for the 6 m level was favoured due to the immature nature of the soil and the probable late age of the artefacts.

Similar ideas were expressed by Sharma (1976) who attempted to obtain radiocarbon dates for the various lagoonal stages (Agrawal *et. al.*, 1977). It is unfortunate that none of the shells were checked for contamination, and moreover, a sample of aeolianite was submitted as a coral for dating. In view of these problems it is felt that little reliance can be placed on the dates, except possibly those from offshore (Table 2). Reliable dates have been obtained by Stoddart and Pillai (1972) when working on raised corals at Rameswaram and Mandapam. The corals were found to reach a maximum height of 0.5 m above present sea level and to be overlain by up to 2 m of carbonate-cemented marine sand. They were dated to 4020±160 BP, but the authors felt that the evidence was insufficient support of a mid-Holocene eustatic transgression. The most recent work in the area has been carried out by a Japanese team (Fujiwara, 1980) who examined the sedimentary sequence of Cape Comorin (Kanya Kumari). They identified landsnails buried in a calcareous marine terrace (4 m asl) and in a thin palaesol developed on top of the fossil dunes resting on the terrace, Radiocarbon dating suggested an age of

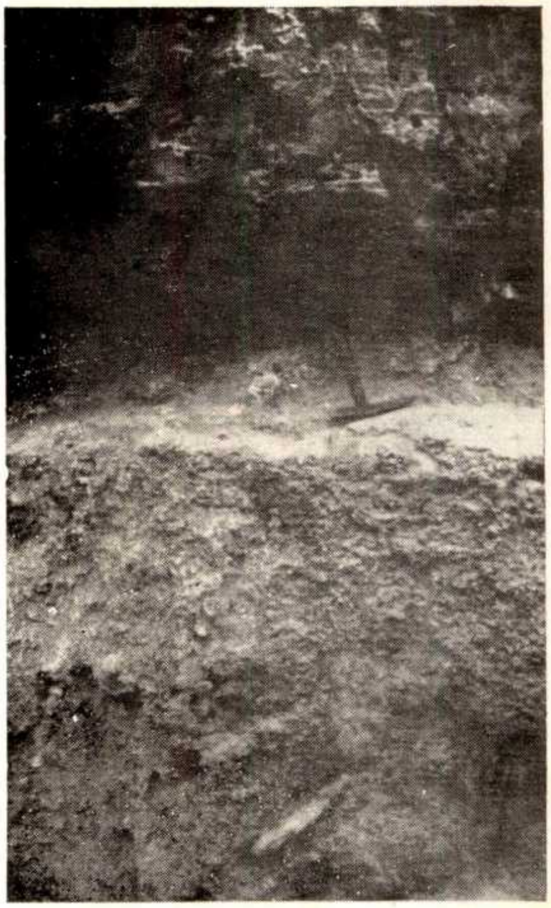
TABLE 2

Material	*Depth (below sea level)*	*Age (years BP)*
Marine shells	11.6m	$26{,}000^{+2600}_{-1900}$
Calcareous Matter	11.4m	$32{,}100^{+2100}_{-1700}$
Limestone	12.7m	>40,000

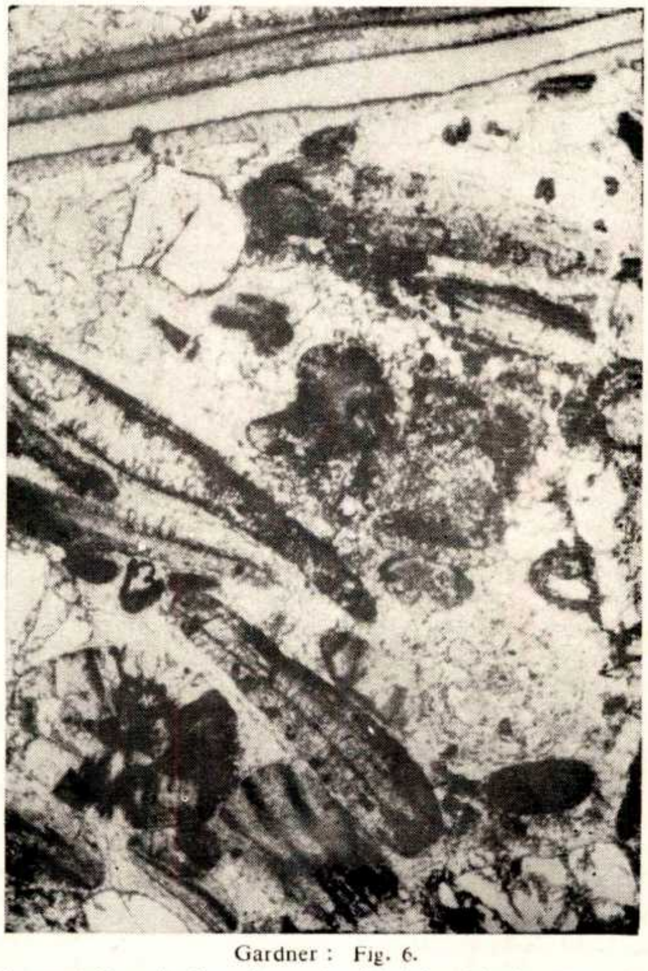

Stage 1 Coastal progradation
sediment
dune
lagoon
offshore bar
sea level
Stage 2 Infilling of lagoon and dune migration
dunes blown inland across infilled lagoon
Stage 3 Dune weathering
red dune (weathered)
fossil lagoon and bar
lower sea level
Stage 4 Coastal progradation
red dune
dune
lagoon
rise in sea level
Stage 5 Coastal development near Tuticorin
Series 1
Series 2 (mid Holocene?)
red dune
fossil lagoon / bar
15m
red dune
fossil lagoon / bar
6m
modern lagoon / bar
s.l.



Gardner : Fig. 4.
Recrystallized Scleractinian corals and embedded bivalve from the upper layers of the fossil near Ovari.

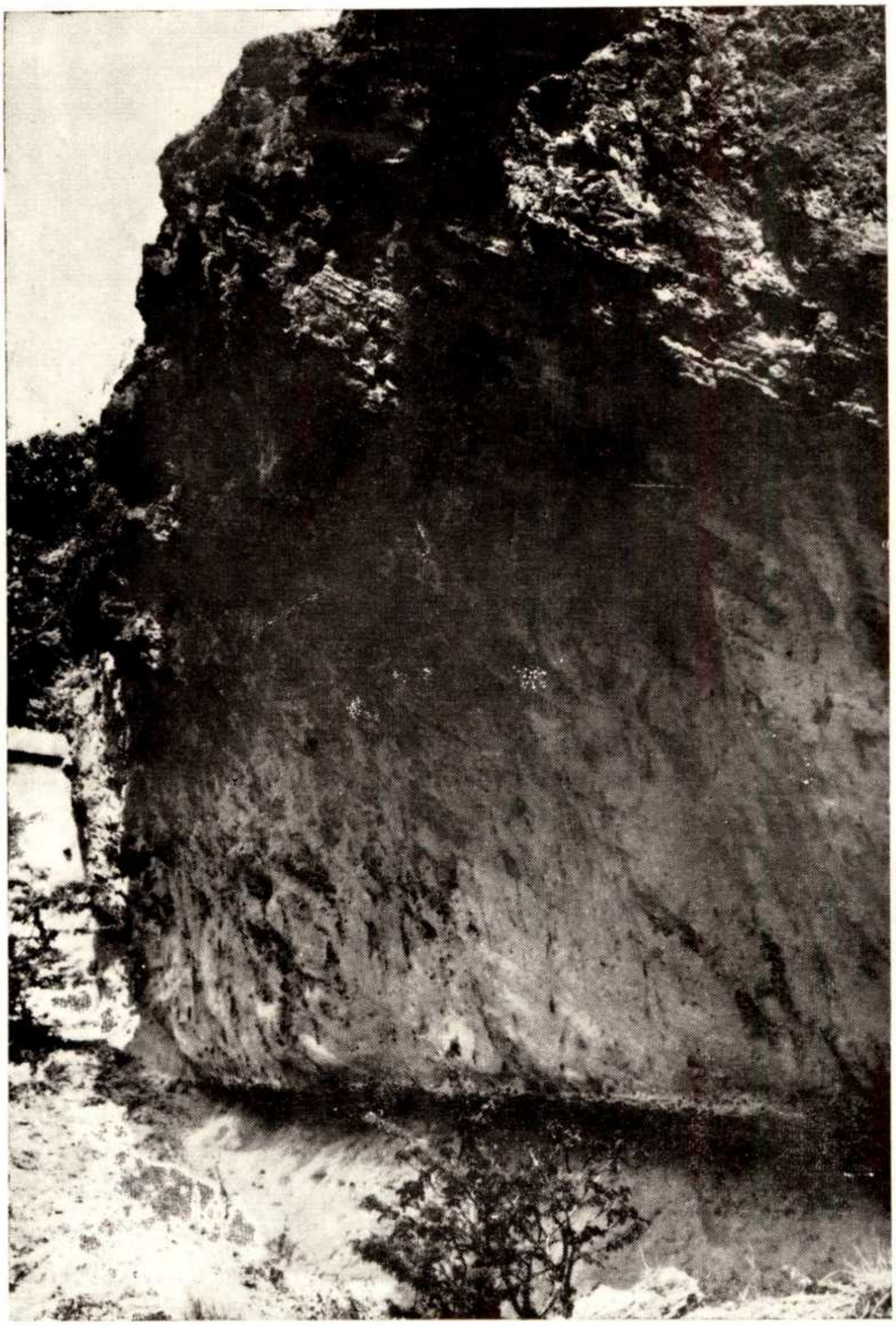


Gardner : Fig. 5.
Coarse marine sandstones of the Idindakarai Series overlain by aeolianite (Kanya Kumari Series), as seen in a cliff at Kanya Kumari. All sediments are cemented by low-Mg calcite.

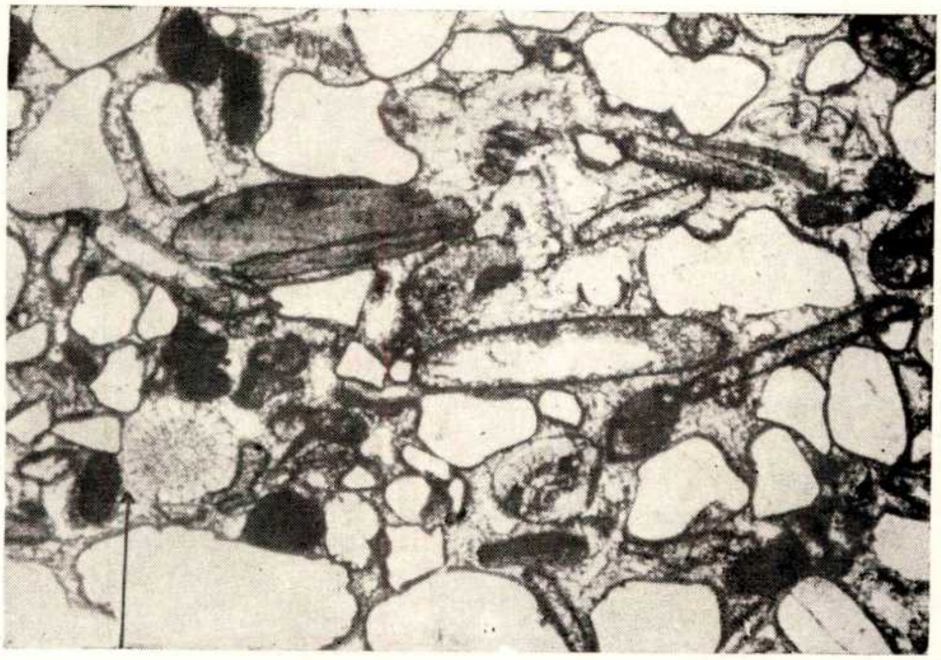


Gardner : Fig. 6.

Unsorted diosparite from the marine Idindakarai Series, illustrating the two generations of inter-particle cement (rim and pore-filling) and syntaxial rim cement. (x40)

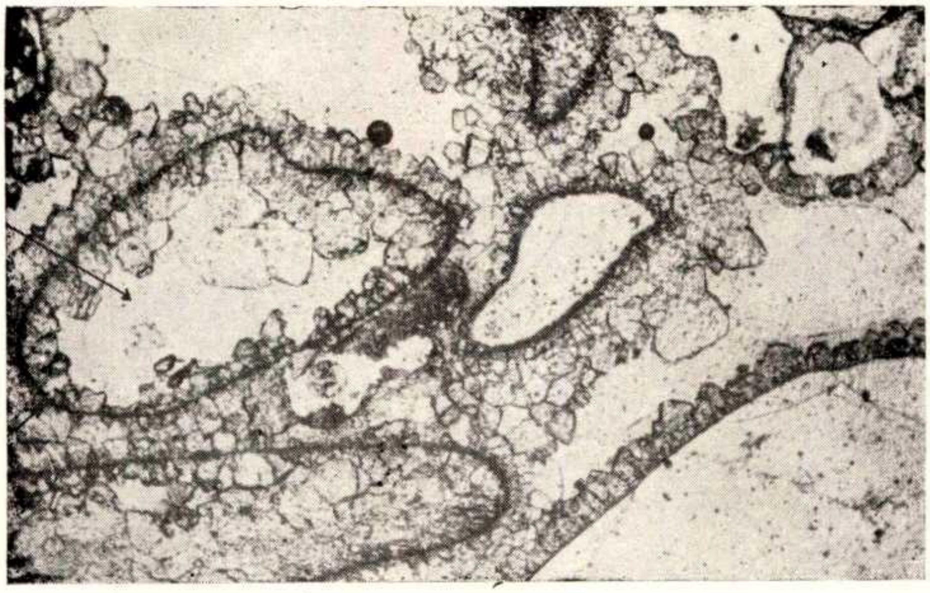


Gardner: Fig. 7.
High-angle bedding in cliffed aeolianites near Thiruchendur.



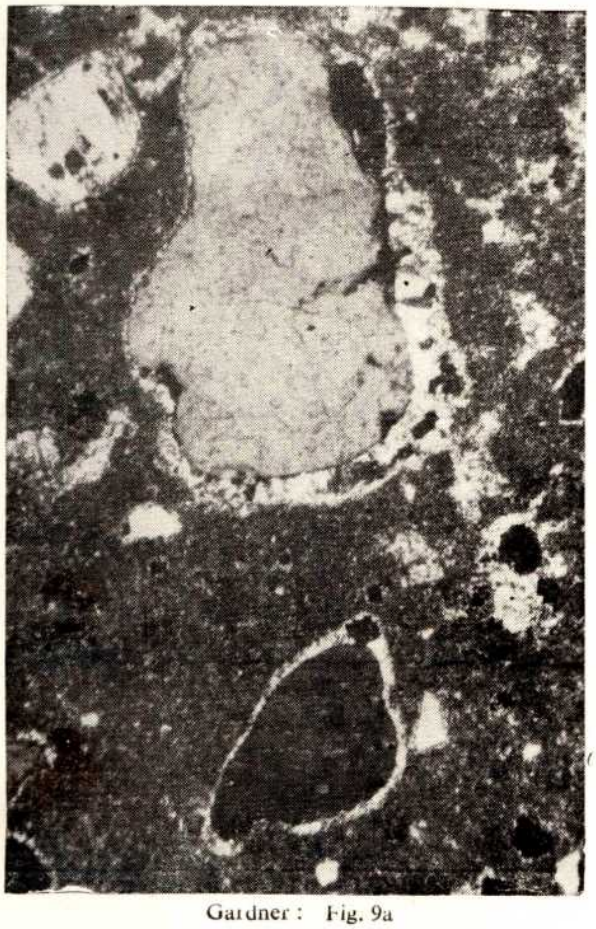
Garduer : Fig. 8a

Well-cemented aeolianite in which can be seen syntaxial rim cement around an algal fragment (as arrowed); two generations of calcity spar; dissolution and partial infilling of aragonite allochems whose outlines are preserved by micrite envelopes. (x40)



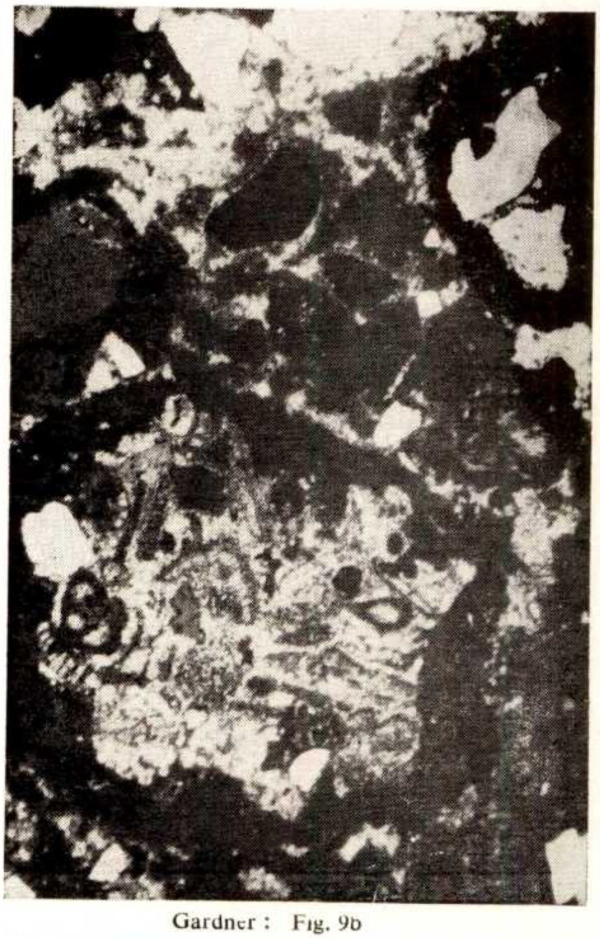
Gardner : Fig. 8b

Details of inter-and intra-particle cement. (x60)



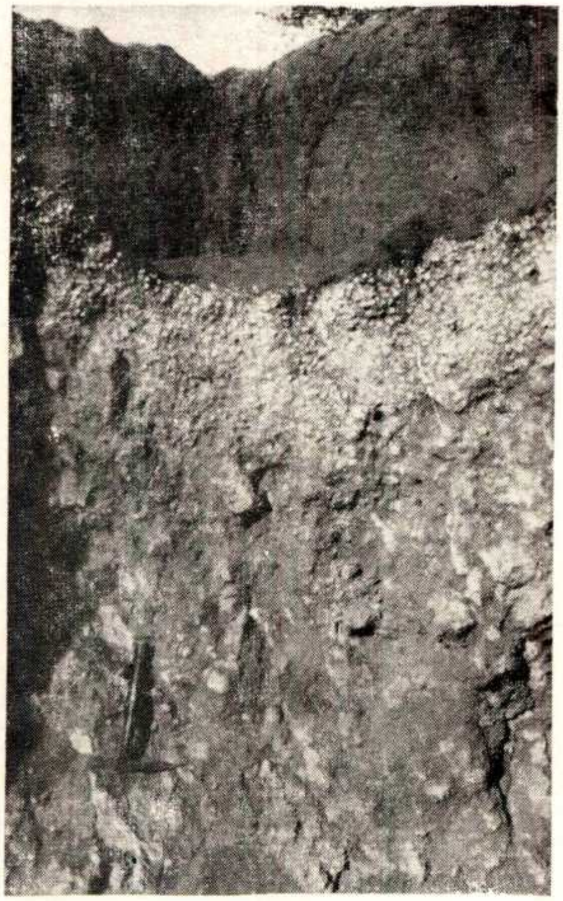
Gardner : Fig. 9a

Terrigenous grains 'floating' in a dense micrite matrix. Larger, sparry calcite crystals, and cavities, form a rim around some of the grains. (x64)



Gardner : Fig. 9b

Micrite surrounding and isolating pockets of aeolianite in the basal section of the massive calcrete (Poochikkadu Series). (x40)

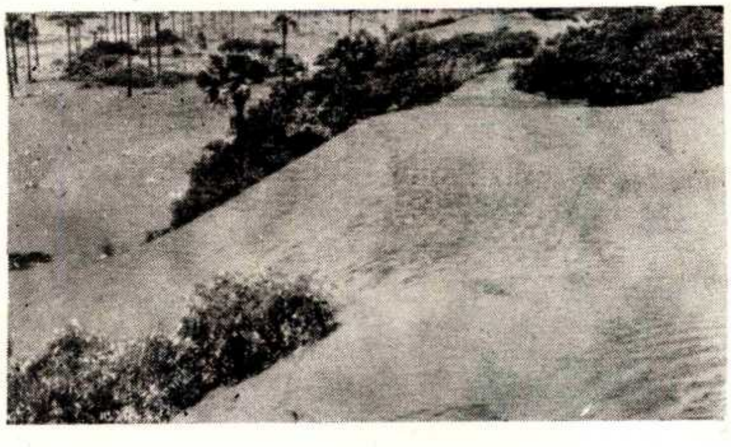


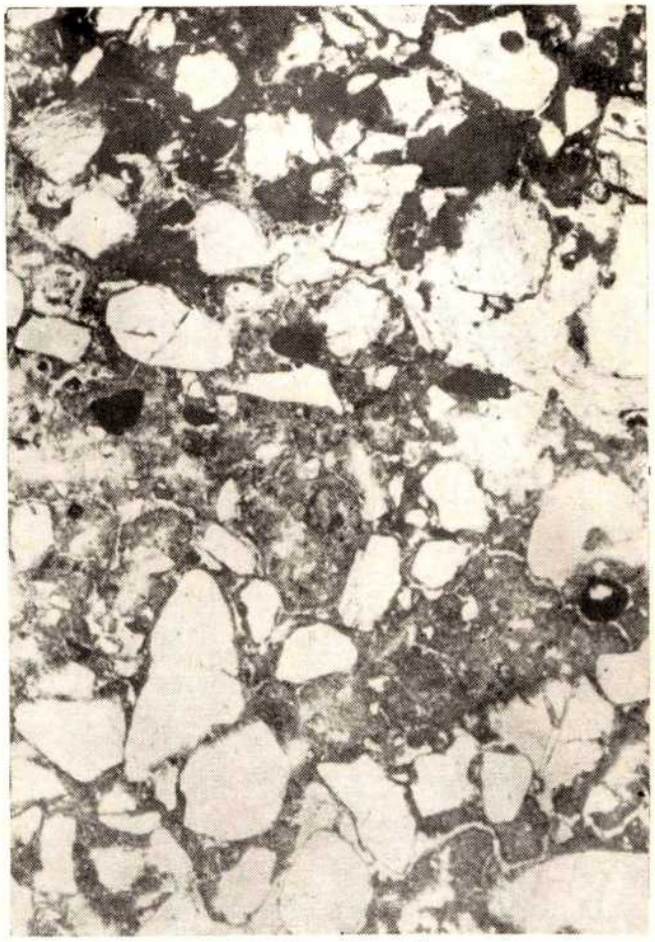
Gardner : **Fig. 11**

Reworked teri sands forming transverse ridges on the surface of the indurated teri 'mounds'. Note the concentrations of heavy minerals in the ripple troughs.

Gardner : Fig. 10

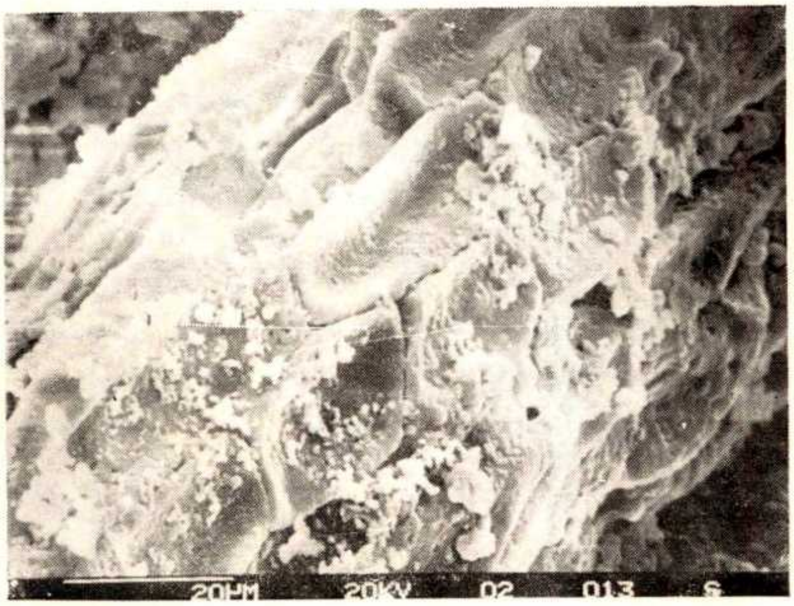
Concentrations of *Helix Vittata* shells and casts embedded in the upper layers of the calcrete, which is underlain by aeolianite and overlain by structureless teri sands.





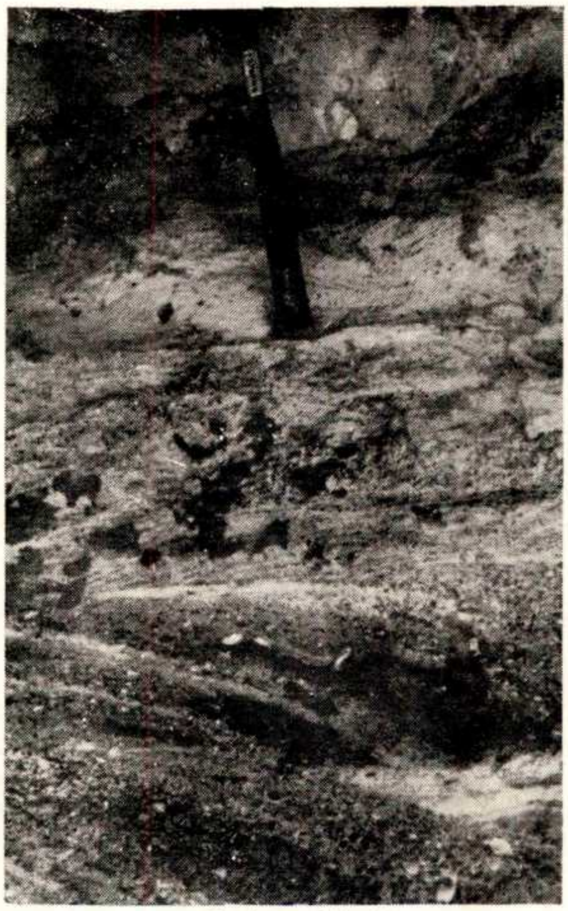
Gardner : Fig. 12

Details of teri sand in thin section, showing sand sized grains within the clay/iron oxide matrix, and the presence of numerous voids. This is one of the least weathered samples. (x40)



Gardner : Fig. 13

SEM photograah showing perfect preservation of cell structures by opaline silica.



Gardner: Fig 14

Trough and planar cross-bedding in sands and gravels of the Mandapam Series, higher energy facies, to the north of Tuticorin.

26,500±445 BP for the former shells and 2940±95 BP for the latter. Due to the possibility of contamination, (which was not checked) and on the basis of correlation, the marine terrace was assigned to the last interglacial.

Field and Laboratory Methods

Field observations were recorded throughout the area between Rameswaram and Kanya Kumari, making use of cliff sections and innumerable wells, some extending over 30 m in depth. All heights are approximate, given the impossibility of surveying the whole area in the time available.

Laboratory analysis of over 250 samples included examination of texture, mineralogy, chemistry and diagenetic fabric. Grain size was determined by sieving for the sand and gravel fractions (as described in Carver, 1971), after removal of calcium carbonate cement, and clay/iron oxide matrix where necessary. Silt and clay fractions were retained and analysed using the photo extinction method (as described by Rendell, 1974) and pipette analysis. The grain size characteristics are summarised in Table 3. Grain roundness was estimated visually under a binocular microscope with reference to the Powers scale (1953).

Mineralogy and diagenetic fabric was analysed primarily from thin sections. The uncemented sands were impregnated with a clear glue (UHU) prior to sectioning, and as far as possible undisturbed samples were used. Estimates of percentage of specific minerals, allochemical material and matrix (by volume) were made using an automatic stage and counter. X-Ray Diffraction was employed in the identification of aragonite/calcite, hematite/goethite, and clay minerals. Sample preparation differed in each case : the carbonates were powdered ; the ferric oxides were concentrated by the removal of clays using 0.5M NaOH as described in Black *et. al.* (1965), and then pipetted onto a glass slide ; and the iron oxide was removed from the clay fraction by the dithionite method of Mehra and Jackson (1960) with modifications by Black *at. al.* (1965), before the clay paste was spread onto a glass slide. Both untreated and Mg saturated samples of clays were analysed. Copper and cobalt anodes were used in the X-Ray analysis.

The chemistry of samples was analysed, following digestion, using AAS techniques. The carbonates were dissolved in 10% HCl and 0.2% lanthanum chloride was added to the solute to lessen the inhibiting effect of dissolved aluminium. The free iron oxides were extrcted by the sodium-citrate-dithionite method (Mehra and Jackson, 1960) which removes both amorphous and crystalline free oxides.

The stable isotope determinations involved preparation of CO_2 from the carbonate sample by acidification with 100% orthophosphoric acid (H_3PO_4) at 25°C vacuum (McCrea, 1950). The δ^{13} and δ^{18} values were measured relative to the PDB standard, with analysis on a 602C Micromass Mass Spectometer (courtesy of Dr. P. Ireland). The radiocarbon ages on the marine sediments are corrected for isotopic fractionation by the normalisation of the $CaCO_3$ shells to −25% PDB, but no isotopic correction was applied to the landsnail samples.

The stratigraphy

Ovari Series

The oldest deposits, resting unconformably on the basement igneous and metamorphic rocks are particularly widespread in the areas around Ovari, Tisaiyanvilai and Panamparai (see Figure for locations), although they occur in patches along most of the coastline. Termed the Ovari series, from the type locality, they are found at heights of up to 18 m above present sea level, but at Ovari they more usually reach 15 m. Several facies are present within the deposits, the most striking being the remains of recrystallized reef limestone *in situ*. Found near Ovari, the small reef knoll trends approximately parallel to the modern shore but at about 2 km inland. The reef limestones reach thicknesses of over 6 m in places, and comprise Scleractinian corals (Figure 4). Unfortunately, much detail has been lost following complete recrystallization to low-Mg calcite, indicating diagenesis under subaerial conditions. Beneath the coral and in some areas where the coral is absent there are calcareous marls and standstones in which a few whole shells are embedded as well as numerous shell casts infilled with gypsum.

Further inland, at Tisaiyanvilai for example, there is a near-shore shallow-water marine facies comprising coarse quartz grains and shell fragments recrystallised to low-Mg calcite cemented in a low-Mg calcite matrix. The proportions of terrigenous grains, orthochemical cements and

TABLE 3

Series -	Major Mode	Second Mode	% sand		% silt		% clay		roundness of grains	skewness		kurtosis		sorting (0)	
			mean	range	mean	range	mean	range		mean	range	mean	range	mean	range
Ovari and Idindakarai	highly variable	only in clay sizes in lagoonal sediments	87.08	64.94 to 98.70	5.70	0.80 to 12.56	7.22	0.50 to 22.61	SR and SA	③ 0.13	0.01 to 0.32	1.38	1.04 to 1.91	1.08	0.89 to 1.30
Kanyakumari	1.5 - 2.0ϕ	-	96.05	89.50 to 97.55	3.63	1.41 to 9.86	0.32	0.24 to 0.83	SR and SA	0.15	-0.27 to 0.34	1.30	0.97 to 2.33	0.65	0.45 to 0.79
Poochikkadu	1.5 - 2.0ϕ	(in clay sizes in the nodular layer)	96.14 ① 86.39 ②	NA 78.58 to 95.42	NA 6.07 ②	NA 1.93 to 8.49	NA 7.54 ②	NA 2.65 to 12.93	SR and SA	① 0.18	0.15 to 0.21	1.28	1.01 to 1.52	0.74	0.68 to 0.81
Teri	1.0 - 1.5ϕ or 1.5 - 2.0ϕ	in clay size fraction	80.04	64.03 to 94.12	4.41	2.25 to 7.37	15.55	3.63 to 31.01	SR and SA	NA	NA	NA	NA	NA	NA
Mandapam (lagoonal)	variable	in clay size fraction	62.28	NA	11.90	NA	25.82	NA	SR and SA	NA	NA	NA	NA	NA	NA
Modern dunes	2.0 - 2.5ϕ	-	99.61	99.10 to 99.64	NA	NA	NA	NA	SR and SA	-0.03	-0.07 to 0.00	1.00	0.93 to 1.11	0.71	0.5 to 0.78
Modern beach	highly variable	-	99.49	98.20 to 100.00	0.29	0.00 to 0.43	0.23	0.00 to 0.80	SR and SA	-0.07	-0.20 to 0.04	1.02	0.68 to 1.51	0.71	0.37 to 1.20
Alluvium (coastal plain)	variable	in clay size fraction	75.46	72.92 to 83.05	9.44	5.60 to 14.88	15.10	12.20 to 21.70	SR and SA	NA	NA	NA	NA	NA	NA
Red earths (in Ghats)	1.5 - 2.0ϕ	in clay size fraction	56.23	46.59 to 83.43	11.74	6.52 to 15.78	32.01	10.05 to 44.60	SA	NA	NA	NA	NA	NA	NA

NA: Insufficient samples analysed or data not in the required form

SA: Subangular

SR: Subrounded

① samples from the base of the calcrete

② samples from the weathered nodular horizon

③ these calculations do not include the lagoonal sediments allochemical shell fragments are highly variable within these sandy limestones, which are similar to those described in detail for the Idindakarai Series. A comparable range of sedimentary environments to those present in the Ovari Series can be seen today around Mandapam.

In addition to post depositional alteration of the carbonates, former weathering of the surface of the sandy limestones led to the formation of small pipes and other karst-like features. The solution may be contemporaneous with the deep weathering of the overlying red (Teri) sands, for, in places, the reddening extends down into the limestones. Unfortunately, the Ovari sediments were not suitable for dating owing to the widespread recrystallisation.

Idindakarai Series

The succeeding set of deposits, the Idindakarai series, was laid down to the seaward of the Ovari series, and are found along much of the former coastline between Kilakarai and Kanya Kumari. The difference in height of these two series suggests that they are not likely to be contemporaneous. Reaching a maximum of 9 m above sea level on their inner edge, the Idindakarai series slopes down gradually towards the east. Mostly the deposits are found at about 6m above sea level, but in one or two places they are only preserved at heights of 3 and 4 m, as at Kanya Kumari (Figure 5).

Typically, the Idindakarai deposits are composed of terrigenous grains of gravel and sand sizes, shell fragments, foraminifera, algae, and low-Mg calcite cement. A shallow-water marine origin is indicated by a variety of evidence including the near horizontal or gently sloping surface of the sediments and the structure of the deposits. Horizontal and seaward dipping laminations of light and heavy mineral grains (sand sizes) and shell fragments are common, as are trough-cross bedded sands (sets usually less than 30 cm thick). The coarse grain sizes and moderate to good sorting also supports a marine origin in some instances, although other samples exhibit grain size characteristics similar to the aeolian sands. Lastly, the presence of benthonic rather than planktonic forams, marine shell fragments (no whole shells) and few fine sediments suggests a shallow-water higher energy zone. In places, such as at Idindakarai, the uppermost layer of the marine sediments consists almost entirely of crushed shell fragments, similar to these exposed on the less sheltered modern beaches and berms. However, interpretation remains a problem given the difficulty of differentiating between beach deposits and nearshore high energy sediments.

In a few locations, notably near Kulattur and Chettikulam, this high energy facies passes laterally into sediments of lower energy environments—lagoonal or estuarine. At Chettikulam, for example, abundant whole shells of *Ostrea* and *Meretrix* species are preserved in life position within horizontally bedded sandy silts and clays. At Davispuram, gypsiferous clays are common. Similar environments are seen today near Tuticorin and at the mouth of the Nambiar River.

In all of the high energy marine sediments identified the mineralogy of the sand grains reflects that of the local source areas. Typically, the sands comprise quartz (81%), feldspar (12%), opaques (2%), garnet (4%), sillimanite and zircon (1%). It is noticeable that few pyroxenes and augite grains were observed within the marine sands, both today and in these earlier sediments, even though they are found in the Archaean source rocks. The terrigenous component of the sediment was found to vary enormously between samples. At Kanya Kumari, for example, the Idindakarai sands contain over 7% (by volume) of terrigenous grains, whereas near Idindakarai it was as low as 20%.

The allochemical content was found to vary between 1% and 31% (by volume), however it must be borne in mind that dissolution of the shells during the early stages of diagenesis may affect the amounts observed. In most samples, the former existence of shell fragments was indicated by micrite envelopes, and this together with the grain to grain contact of the particles suggests that the estimates of allochemical content are not very biased. Shell fragments, foraminifera and algae were common components of the allochemical fraction, and among the shell species identified were *Conus*, *Mytilus*, *Lucina* and *Cypreae*.

The cement in the shallow-water marine sandstones varies between 28% and 74% by volume, as calculated from thin section. The results of X-Ray Diffraction and AAS analyses show the carbonate content of the sample as a whole (allochems and cement) to comprise low-Mg calcite, with $MgCO_3$ amounts of 2.5 mole % and less. The $SrCO_3$ content is also very low at less than 0.2 mole % in every sample analysed. These results indicate that most, if not all, the original aragonite and high-Mg calcite in the allochems has been dissolved or replaced, and low-Mg calcite cement precipitated under subaerial conditions.

A detailed description of the diagenetic textures can be found in Gardner (1981a). The degree of diagenetic alteration differed between samples and sections and it was not possible to identify progressive stages in the diagenesis. The observed differences appear to relate to variations in the local environmental conditions. The majority of the samples from the high energy facies could be classified as sorted and unsorted marine biosparite, in which the allochemical and terrigenous grains are set within a spar cement. Micrite envelopes, probably the result of algal boring (Bathurst, 1971), are commonly observed around the mollusc fragments, most of which are rounded and abraded. Many of the forams are also abraded, and are infilled by pyrite, which may indicate the existence offshore of oxygen-poor waters associated with vegetation (Clark and Lutz, 1980).

Over 80% of the aragonite shell fragments have been dissolved, leaving molds preserved by micrite envelopes or by pre-existing low-Mg calcite cement that had formed a rim around the fragment. Some molds are infilled with equant crystals of calcite spar. Two generations of interparticle cement can be seen; a smaller sized calcite spar (equant or bladed crystals 10—20μ in diameter) as rim and meniscus cement, and larger sparry crystals (rhombohedral, 30—100μ) infilling some of the interparticle pore spaces (Figure 6). The pore filling cement is not present in all samples, and so porosity (moldic and interparticle) may remain high (up to 60%), but is as low as 10% in other samples. Syntaxial rim cement is present on some forams and all echinoderm grains.

Aggrading neomorphism (the process whereby micron sized aragonite or calcite is replaced by coarser, decimicron sized calcite *in situ*) was observed in mollusc fragments in some sections, in addition to the solution and cavity filling processes The replacement to low-Mg calcite spar is identified mainly from the preservation of ghost structures of the old shell within the new spar. Other distinguishing characteristics (Bathurst, 1971) were not found to be particularly useful. Thus the growth of neomorphic spar has taken place at an early stage in the diagenesis, and in some sediments with a low volume of interparticle cement.

When dense aragonite is dissolved and reprecipitated as less dense low-Mg calcite an 8% volume surplus is created. It is possible that the rim and a little of the interparticle pore cement is derived locally from dissolution of aragonite. In some cases this can account for the total volume of cement, as at Kanya Kumari. In well-cemented samples, however, this local source of cement is not sufficient to account for the degree of cementation involved. An additional, external (allochthonous), source needs to be identified. This may well be the overlying calcareous dunes, but it is difficult to furnish proof of such a source.

On the exposed fossil marine surfaces, that is those which are not presently, and were possibly not in the past, covered by aeolianite, there is evidence of calcrete formation. Massive calcretes up to 1 m thick have developed in the upper layers of the biosparite. The processes involved will be discussed in more detail later.

The silts and clays of the lower energy facies show little evidence of cementation, and some of the shells preserved within them retain their original aragonite mineralogy, due probably in part to the relative impermeability of the sediment. This has made it possible to obtain a date for these sediments. Shells in life position within these clays near Panaiyur were extracted for radiocarbon dating and yielded a date of $38{,}100\,{}^{+1260}_{-1100}$ (SRR 1482). The shells were checked for contamination using X-Ray Diffraction, thin section and isotopic techniques. The δ^{13} C value was 0% which is within the limits set by uncontaminated shells within similar environments today (Keith *et. al.*, 1964). The other methods also revealed no signs of contamination in this sample, although dubious samples from other areas were discarded. The date, however, presents problems in that it is near the acceptable limit of radiocarbon dating. A mere 1.0% contamination by modern carbon of a sample 100,000 years old will give a date of 38,000 BP (Kim *et. al*, 1969). There is, as a result, some uncertainty surrounding the date; if it is correct there are important implications for relative sea level changes during the last glacial, and if not it is likely that a small amount of contamination has affected a sediment deposited during the high sea level stands of the last interglacial. It is hoped to find more shells suitable for dating this deposit in the near future.

Kanya Kumari Series

Overlying few of the Ovari deposits but most of the high energy deposits of the Idindakarai series is a distinctive deposit termed the Kanya Kumari series. It rarely overlies the lower energy deposits of the Idindakarai series. Evidence from field and laboratory studies suggests that this is a set of fossil coastal dunes cemented by calcium carbonate (aeolianite). The dune-shaped ridges rise to over to 60 m above sea level and were included in the sediments identified by Foote (1883) as 'calcareous grits'. The individual ridges appear to trend in a direction parallel to oblique to the present shore, although reconstruction is difficult from the well sections available. Since there is no field evidence to support a post-depositional origin for the troughs between the ridges, it must be concluded that the sands were laid down in such a configuration. The ridges form a belt of deposition roughly parallel to the modern coastline between Kilakarai and Kanya Kumari.

The internal structure of the sediments, where exposed in wells and cliffs, consists predominantly of high-angle, cross-bedded sets, most exceeding 1 m in thickness (Figure 7). Such bedding extends inplaces to depths of 20 m and more, is rarely observed in sediments other than dunes (Reading, 1978). An analysis of the grain sizes shows the texture of the sands to be compable with an aeolian origin, namely well-sorted medium to fine-grained sands with less than 5% (by weight) in the silt/clay fraction. Measures of skewness and kurtosis were not found to be useful when distinguishing between the dune sands and some of the finer, and well sorted, underlying marine sediments. The grain size distributions of the aeolian sands are typically slightly positively skewed. There appear to be no systematic changes in grain size characteristics along the coastline or within any of the sections, with the exception that the basal sands are often coarser.

The mineral grains, which comprise between 17% and 66% by volume of the samples, include quartz (18%), feldspars (10%), garnet (3%), opaques (4%), sillimanite, zircon and a small number of pyroxenes (as in the marine sediments) Quartz is by far the most common of the minerals present. Of the heavy minerals garnet is often present in surpisingly large quantities (up to 14%), in addition to ilmenite and magnetite, especially in the finer sand fractions. Very few of the mineral grains appear, in thin section or under the SEM, to be weathered, suggesting either a local source area and/or rapid deposition. However, the more easily weathered minerals appear not to have survived either transport to the sea, or physico-chemical attack in the marine environment. The allochemical particles include fragments of bivalves, gastropods, echinoderms, forams and algae. The types of foraminifera present are listed in Table 4, and are all benthonic varieties occupying shallow water (less than 200 m) marine environments and have existed since the Tertiary.

TABLE 4

Suborder	*Superfamily*	*Genera*	*Environment*
Miliolina	Miliolacea	Quinqueloculina	Benthonic
		Peneroplis	Benthonic
		Triloculina	Benthonic
Rotaliina	Rotaliacea	Ammonia	Benthonic
		Operculina	Benthonic
		Nummulites	Benthonic
		Elphidium	Benthonic

No Textularids present ; Miliolids are more common than Rotalids.

Analysis of the calcium carbonate cement shows it to consist of low-Mg calcite. This is consistent with the equant sparry nature of the cystals, and indicates cementation of the aeolianite under subaerial conditions. The cement mostly accounts for 20—40% of the volume of the sediment, with pore space of upto 34%.

The analysis of the diagenetic fabric of over 60 samples did not reveal systematic changes in texture either spatially in the field area or vertically in any one profile. Thus, a diagenetic sequence over time could not be established, unlike the studies by Land *et al.* (1967) and Gavish and Friedman (1969). Most of the terrigenous grains appear relatively fresh and unaltered by the diagenesis, except for the replacement of the edges of a few of the quartz and feldspar grains by microspar (crystals than 5µ in diameter). This is more common in the upper layers of the a eolianite. Similar replacement is seen in the overlying calcretes, and has been reported from aeolianites in Israel (Amiel, 1975). Replacement may be associated with changes in CO_2 pressure linked to organic decay (Siever, 1972) or with externally controlled changes in pH levels (Walker, 1962).

Chemical and thin section analyses indicate that the allochemical fragments have been altered to low-Mg calcite from their original high-Mg calcite and aragonite mineralogy (see Bathurst, 1971, for theoretical details). Mg^2X has been removed selectively from the lattice of the high-Mg calcites, leaving low-Mg calcite, with no change in the fabric. The dissolution (congruent) of aragonite is marked by micrite envelopes, which show the original outline of the fragment(s) many of which have been infilled subsequently by calcite spar (Figure 8a) There is no indication of fracturing of the molds in any sample. Many of the samples also showed evidence of aggrading neomorphism in mollusc fragments.

The calcite cement takes three forms. First, syntaxial overgrowths or rim cement has formed especially on echinoderm fragments, with the overgrowths filling the whole of the adjoining pore space. Secondly, intraparticle cement fills the molds left after the dissolution of the aragonite. Crystal size increases from the edge of the molds inwards and the proportion of molds infilled in this way varies from sample to sample (Figure 8b). Thirdly, there are two generations of interparticle cement. The first generation comprises small blocky or bladed crystals, 10–20µ in diameter, forming a rim cement. The second generation of rhombohedral spar crystals infills the pore spaces with crystal sizes ranging from 40 to 150µ in diameter (modal size is 50µ). Generally the samples with two generations of pore filling cement also contain more mollusc fragments, whereas the samples with only the first generation of cement are often richer in foraminifera or contain few allochemical fragments. Thus, the first generation may be supplied from localised dissolution, as this seems to take place very rapidly in the early stages of diagenesis (as shown in the recent dune sands). Most, if not all, the cementation observed took place above the fossil water table, given the likely topography, configuration of the land surface and drainage within the sediments.

As a result of cementation the porosity has been reduced to less than 20% by volume in most samples. The 8% increase in volume brought about by the dissolution of aragonite and its reprecipitation as calcite cannot account for all the cement observed. At the maximum only about 10% of the cement can be accounted for by this volumetric increase. Other sources identified elsewhere include groundwater (Land, 1970), the overlying or adjacent sediments (Bretz, 1960; Vedder and Norris, 1963; Land *et. al.*, 1967; Gavish and Friedman, 1969), and dust particles (Bathurst, 1971). Unfortunately none of these are particularly convincing in the context of southeast India, where the source of cement, as in many aeolianites, is not at all obvious (Gardner, 1982).

A groundwater source can be discounted in all but a few instances in the Kanya Kumari series since capillary rise would have to operate over several tens of metres. Moreover, there is little fossil evidence of vegetation within the aeolianites which have aided the process. Calcium carbonate supplied by the leaching of overlying sands seems more plausible, but since the surface of the aeolianite has been sealed in most places by a calcrete, these sands, once decalcified, must have been removed prior to calcrete formation. There are no decalcified sands of this age present in the area today. Moreover, the amount of sand required to supply the necessary cement would seem, from a crude calculation, to be in the order of 100 m. This estimate is based on the need to supply 80% of the observed cement in 20 m of aeolianite, with the overlying sands containing an average of 18% shell fragments, and allowing for nondisplacive cementation and total redeposition of the dissolved carbonate. In the light of these problems it is unlikely that this mechanism can account for the majority of the cement.

Lateral flow as a source of calcium carbonate is not supported by the evidence in the sections, although fewer sections were available in the higher dune areas, and so the hypothesis could not be fully tested. Aerosols are also unlikely to be able to supply carbonate on the scale required within the time limits. Using average worldwide rates of dust accumulation and data on the gross chemistry of dust storms (Goudie, 1978), calculations indicate that cementation would take about 600,000 years (5mm maximum of CaO deposited per 1000 years). At the moment therefore there is no readily apparent source of the calcium carbonate making up the majority of the cement in the aeolianites.

In summary, the aeolianite (Kanya Kumari series) is found widely along the coastline, and resembles presently forming coastal dunes very closely in terms of mineralogy, distribution on the higher energy shores, morphology and alignment of dunes.

Poochikkadu Series

This comprises a finely textured, almost impermeable capping to the majority of the aeolianite, and to some of the non-aeolianite covered marine limestones of the Idindakarai series. It is a calcrete, in which the thicker deposits are massive in form and the thinner crusts are characteristically laminar. The thicker calcretes, up to 1 m deep, are commonly found nearer the dune troughs and on the marine limestones, whereas the thinner calcretes occur towards the dune crests and dune blanks exposed to salt spray and onshore winds. In places the upper parts of the calcrete have been weathered, leaving concretions set in an orange-coloured clayey matrix, some of which is derived from the red Teri sands overlying the calcrete.

Chemical analyses of the calcrete confirm that it is composed of low-Mg calcite ($CaCO_3 > 98\%$ of the carbonate : $MgCO_3 \geqslant 2\%$), and its subaerial origin is further supported by the highly negative values of the stable isotopes of carbon (varying from -3.6 to -10.7). In thin section, the body of the massive calcrete comprises a dense micrite matrix (average crystal diameter of less than $5\mu n$), in which the few terrigenous grains are 'floating' unsupported. In most samples the matrix appears structureless, although in some it has the pellet-like or pisolitic texture often found in calcretes (Harrison and Steinen, 1978). Few of the pisoliths have a nucleus. Larger calcite crystals (20μ diameter on average) infill secondary fractures and are found around the rims of some of the terrigenous grains (Figure 9a). In the latter case the spar probably infilled voids created by the grains and matrix pulling away from each orher during wetting and drying cycles (Harrison and Steinen, 1978), and it may be indicative of displacive growth of the calcrete. Partial replacement of some quartz and feldspar grains also appears to have taken place, the grains being embayed by the micrite. Neither marine allochemical fragments nor fungal and plant remains (Cerda, 1974 ; Klappa, 1979a,b) were observed within the calcrete.

The base of the massive calcrete is marked by a gradual transition into the aeolianite (or limestone) below. Patches of equigrannular micrite crystal are seen interfingering with the aeolianite, and a few cm higher in the profile the micrite is found encircling and completely enclosing remnants of unaltered aeolianite (Figure 9b). This gives the aeolianite a brecciated appearance, and a similar texture has been cited by Watts (1978) as evidence for the displacive (rather than replacive) growth of the calcrete. Similar textures were also noted in Barbados where calcrete had developed over porous or permeable substrata (Harrison and Steinen, 1978). The boundary between the two series is therefore conformable and transitional, with the calcrete being formed, partly at least, within the upper layer of the aeolianite.

In contrast, there is considerable evidence for the exposure of the upper surface of the calcrete, in the form of layers of landsnail shells (*Helix Vittata*) embeded within the top 0.3 m or so of the calcrete (Figure 10). At present, similar landsnails are widespread on the modern calcrete surfaces of the coastal plain, on which little sand movement is taking place, and where the rich supply of carbonate necessary for shell construction (Gould, 1977) is available. The accumulated thicknesses on top of the fossil calcrete probably indicate winnowing and concentration of the shells prior to incorporation in the calcrete. Some of the shells have retained their original aragonite mineralogy. This is surprising in view of its instability under subaerial conditions and the active formation of calcrete around the shells. A similar case has been reported from the Yucatan area, Mexico (Ward, 1975), where it was suggested that an external organic coating protected the aragonite and prevented its dissolution. In places, subsequent partial dissolution of the surface of this layer has left landsnail molds and calcrete nodules, the calcrete showing a marked increase in porosity.

The thin calcrete crusts over some of the aeolianite, as at Kanya Kumari, are characterised by laminated and pseudo-pisolitic structures. Laminations are thought to result from calcrete formation on a plugged surface (Harrison and Steinen, 1978) or in association with soil algae, fungi or lichens (Folk and McBride, 1976; Klappa, 1979a). The first of these two ideas is more appropriate in this case as little evidence of biogenic matter can be seen in thin section, and the underlying aeolianite is well cemented. Unlike the massive calcrete, the boundary with the aeolianite is sharp and well-defined, and the crusts contain scattered fossil landsnails rather than thick accumulations.

Thus, most of the aeolianite is capped by a massive calcrete (Poochikkadu series) formed on an exposed land surface, as shown by the incorporation of large numbers of fossil landsnails over a wide area. The stratigraphic position and distribution of the calcrete are further evidence that it is not a groundwater calcrete. At present the calcrete forms an impermeable layer, which diverts the drainage laterally within the fossil dunefields.

Two samples of the aragonite landsnails have been dated using radiocarbon techniques. The shells were checked thoroughly for contamination, prior to dating, by means of X-Ray Diffraction and thin section examination. (The stable isotope values are of no use in this instance since the shells were formed under subaerial conditions, incorporating some soil carbonate at least). The dates obtained on the aragonite shell samples were 25.450±750 BP (BM 1671; calcrete on dune flank at Poochikkadu), and 21,000±400 BP (BM 1670; calcrete at Kayamoli).

Teri Series

This series received attention in Gardner (1981b), where it was suggested that morphological, textural, chemical and mineralogical evidence indicates that the sands originated as coastal dunes and were subsequently weathered *in situ*. The coastal dune sands were blown over the exposed marine sediment, aeolianite and calcrete, covering them, and infilling depressions, to depths of 10m and more. Breakdown of the feldspars, garnets and some opaque minerals led to the formation of a deep red (2.5YR4/8-10R3/6) matrix enriched in kaolinite and hematite. Thus today the teri sands appear as huge reddened mounds rising gently up from the coastal plain, and extending in a broad belt from Kilakarai to Kanya Kumari. The belt is dissected by the major rivers, and there is an outlier of reddened sand at Muttom on the southwest coast. The sands reach their broadest extent between Tisaiyanvilai and Thiruchendur, as do the underlying marine and aeolian series. Any material blown onto the lower coastal plain inland has since been removed, or at least reworked, into alluvium. As the teri sands cover and infill a pre-existing topography, they do not exhibit a surface dune morphology, except where they have been reworked in modern times (Figure 11). Reworking has led to the removal of the clay matrix, leaving a lag deposit of medium to coarse grained, lightly reddened, sand in the dunes.

There is little evidence in support of the idea that the teri sands were derived detritally from the red soils in the foothills of the Ghats, as suggested by Foote (1883). The evidence also lends little support to Zeuner and Allchin's (1956) hypothesis. The red teri sands all appear to be of similar age; no earlier phase of reddening is recorded in any of the sediments, and all the sands have similar morphological chemical and mineralogical characteristics. They do not occupy successive morphological 'steps' in the landscape, separated by fossil lagoons. Thus, to invoke several phases of reddening separated by cycles of lagoon formation and dune migration, is unnecessarily complex.

Weathering of the sands has taken place throughout the profiles, and in some cases passes down into the upper layers of the calcrete or marine limestones. All traces of carbonates, if they ever existed, have been removed from the teri sands and only relatively resistant minerals remain. (Weathering has also destroyed the sedimentary structures). On average quartz comprises 90% of the grains, with small amounts of opaques (5%), sillimanite (2%), feldspars (2%) and zircon (1%). The matrix varies between 5 and 30% by weight (of total sample) and is composed predominantly of clay-sized material. Typically the matrix contains about 2% free iron oxide, 80% kaolinite, and the remainder as illite.

Details of the soil fabric are given in Gardner (1981a). Briefly, the fabric of the matrix was found to be mostly lattisepic and skelsepic, with isotic fabrics where the concentration of iron oxides was particularly high (terms defined in Brewer, 1964). The matrix occupies the intergrannular pore spaces, between the skeleton grains, few of which are the grain-to-grain contact (Figure 12). Evidence of the breakdown of the few remaining feldspars and garnets is to seen in section, however, most of these minerals seem to have been destroyed during the earlier stages of weathering. (This assumes that the original mineralogy of the sands was similar to the younger and older coastal sediments). Voids, such as simple and compound packing voids and skewplanes, are present in thin section, and probably result from shrinkage caused by wetting and drying. Cutans are not well formed around the grains, and where present they consist of weakly differentiated rims of clay minerals and iron oxide. Little contrast in the type of fabric and concentration of material is to be seen between the cutans and matrix. Thus there is little evidence in thin section of large-scale illuviation within the matrix. The absence of horizonation and the gross uniformity of the textural, chemical and mineralogical characteristics down the profile support this conclusion.

At several locations, especially in the thicker deposits directly overlying the Ovari series around Tisaiyanvilai, the teri sands show evidence of silica reprecipitation within and at the base of the reddened profile. In places the silicification extends into the marine limestones. The diagenetic sequence changes from reddened sands at the top of the profile, to silica-cemented sands and sandstone which then passes into carbonate-cemented marine limestones below. It is possible that this represents one complete weathering sequence. On the other hand, the limestones may have been subaerially cemented by carbonate prior to the deposition of teri sands and the formation of opaline silica. The latter is more likely as there is evidence elsewhere of the cementation of aeolianite and the formation of the calcrete before deposition of the teri sands.

The silica-cementation is associated in all cases with the fossilized remains of plant roots. Silica, liberated by the reddening process above, may have been reprecipitated lower down the profile as opaline silica, replacing root structures and cells and providing an interparticle cement (Figure 13). In this case, a deep-rooted system of vegetation probably existed on the surface of the teri sands. Alternatively. a silica-rich root mat of colonizing plants may have existed on the exposed and lightly weathered marine limestones ; and this was subsequently buried and fossilized by the deposition of the teri sands. The role played by the plants in the process of silica fossilization is also unclear as yet. There are at least three possibilities. The organic acids may aid in the release and transport of silica ; the plants may store and concentrate the silica released by weathering as relatively soluble opal phytoliths ; and the plant cells may act as nucleii for reprecipitation or at least, the plants provide a favourable environbent for reprecipitation of the silica. Work on these sediments is continuing, dealing in particular with the association between organic matter and silica cementation, the origin of the silica, and the types and characteristics of the plants involved.

Occasionally, the silica also replaces part of the underlying limestines, preserving the outlines of calcite crystals, foraminifera and molluscs. This can be seen at Tisaiyanvilai.

The reddened sands immediately surrounding the silicified areas appear to contain slightly greater amounts of feldspar (5%) and garnet (2%) in the sand fraction, and in the clay fraction a higher percentage of illite (30%), with less kaolinite (65%). This rubefication therefore seems to be less advanced than in the typical teri sands above.

Unfortunately the teri sands contain no datable material. Abundant microlithic artefacts are both concentrated in surface accumulations and occur as a general scatter over the teri sands, but none were observed *in situ* within the sediment. These artefacts are thought to date to between 4000 and 10000 BP on the basis of dated sequences elsewhere in India (Misra, 1973 ; Sankalia, 1974).

Mandapam Series

The Mandapam series is a marine deposit, rising in most places to between 2 and 3 m above present sea level. It is found fringing the modern shoreline and seaward of the sediments described so far, which in places it cliffs. Located between Mandapam and Kanya Kumari, the series reaches its maximum extent near Tuticorin, where it exceeds 6 km in width. At Mandapam the whole peninsula comprises sediments of this series.

Three facies can be identified within the series. The first, a fossil reef facies is restricted in extent, and usually found only just above present sea level. (Detailed faunal descriptions are given in Stoddart and Pillai, 1972). Best exposures are near Mandapam village and on islands in the Gulf of Mannar. For the most part, the series comprises a high-energy nearshore facies and a lagoonal facies. They do not form a chenier/lagoon sequence, but occur separately on different parts of the coastline, depending on the orientation of the shore and its exposure to the east and northeasterly winds, and nearness to river inlets.

The higher energy facies, comprises sands, pebbles and shell fragments, and is often uncemented. The sediments exhibit (Figure 14) small-scale, trough and planar cross bedding and seaward and landward dipping laminations. They are especially well seen near Thiruchendur, where they form a broad progradational plain over 4 km wide. Mollusc species include *Arca, Cardita* and *Pecten*. These and similar deposits to the south, near Alantalai, are overlain by dune sands formed at the shore as the coastline built out. The dunes are less than 5 m high and are lightly cemented in places by calcium carbonate-low-Mg calcite spar forming rim and meniscus cement. Thin sections reveal the most likely source to be localised dissolution of aragonite shelly fragments. Porosity remains very high.

The lagoonal facies is well seen near Tuticorin, Mandapam and at Alantalai where it extends to over 2 km in width as a flat, low-lying plain. The sediments comprise silts and clays with some interbedded sands and distinct layers of fossil shells. Often *Turitella* sp., along with *Meretrix* and *Cerithium* sp., are found at depth, with layers of landsnails at or near the present surface. Some of the snails appear to be redeposited, where others are associated with thin calcrete layers formed on the dry surface of the exposed lagoon. Most of the shells found in these deposits retain their original mineralogy and are ideal for dating. There is no evidence of dunes crossing these old lagoon surfaces. Similar sediments, but containing *Ostrea* shells, are observed in modern and fossil estuaries, as at the mouth of the Nambiar River.

A radiocarbon date of 4680±50 BP (SRR 1480 ; $\delta^{13}C=0.9\%$) was obtained on molluscs from within the raised lagoonal deposits near Tuticorin. This supports the mid-Holocene date (4020±160 BP ; Stoddart and Pillai, 1972) for the raised corals around Mandapam.

Modern Shoreline

Much of the modern shoreline, especially in areas of higher marine energy, is fringed with calcareous dunes. They reach heights in excess of 20 m at Thiruchendur and Ovari, amongst others, and typically contain quartz, feldspar, garnet, opaque, sillimanite, zircon and hornblende minerals, as in the fossil dune sands. Often the beaches in the high energy areas have zones of mineral separation. The concentrations of heavy minerals can contain as much as 71% garnet and 38% opaque minerals. In contrast, the lighter sands contain up to 24% feldspar grains, with quartz as the most common mineral. Cementation of the beach sands into beachrock is rarely observed, except in the extreme southwest of the Peninsula, where it is quarried as a local building stone.

Elsewhere on the coastline there are areas of lower energy, with bodies of water separated or protected from the sea by narrow sandy beaches or promontaries. The vegetation is that of tropical salt marshes ; mangroves are uncommon on this coastline. Particularly sheltered areas are found near Valinokkam, Tuticorin and Kovakulam, and coral reefs fringe some of the offshore islands in the Gulf of Mannar. Modern invertebrate fauna includes *Arca, Cardium, Cerithium, Conus, Meretrix, Mytilus, Pecten, Terebra,* and *Turitella* sp., in addition to a variety of foraminifera and algae.

Conclusion

The foregoing descriptions indicate that the extreme southeast tip of India contains one of the most extensive sequences of Quaternary sediments identified in Peninsular India. The last 100,000 years or so are represented by a sequence of marine and aeolian sediments that have been highly altered following deposition and exposure on the land surface. They are variously indurated by iron oxides and clay minerals, calcium carbonate (low-Mg calcite) or opaline silica. The stratigraphy and associated major processes are summarised in Table 5, and diagrammatically in Figure 15.

The age of the Ovari Series is unknown, and that of the Idindakaarai Series remains uncertain given the problems of radiocarbon dating, even though every effort was made to date uncontaminated samples. It is possible, therefore, that the Idindakrai sediments formed during the relatively high sea stands of the last interglacial, or around 38,000 BP as suggested by the radiocarbon date. The dunes of the Kanya Kumari Series were

TABLE 5

Series	Major Processes	Dating (yrs BP)
modern	deposition of beach/dune & lagoonal sediments	
Mandapam	partial $CaCO_3$ cementation	
	low energy and high-energy, lagoonal/marine deposition (2 - 3m. a.s.l)	4,680 ± 50
Tori	diagenesis involving reddening/weathering	(16,000 - 5,000, and subsequently)
	diagenesis involving silicification ?	
	aeolian deposition (coastal sands)	(17,000 - 20,000)
Poochikkadu	calcrete formation on aeolianite and some marine sediments	21,000 ± 400 25,450 ± 750
Kanyakumari	diagenesis involving subaerial cementation by $CaCO_3$	
	aeolian deposition (coastal sands)	
Idindakarai	$CaCO_3$ cementation; subaerial diagenesis ①	
	low-energy and high-energy, lagoonal/marine deposition (6-9 m. a.s.l)	$38,000^{+1260}_{-1100}$?
Ovari	$CaCO_3$ cementation; subaerial diagenesis ①	
	low-energy and high-energy, lagoonal/marine deposition; coral reef (15-18 m. a.s.l.)	

Extrapolated dates shown in parentheses.

① Possibly contemporaneous

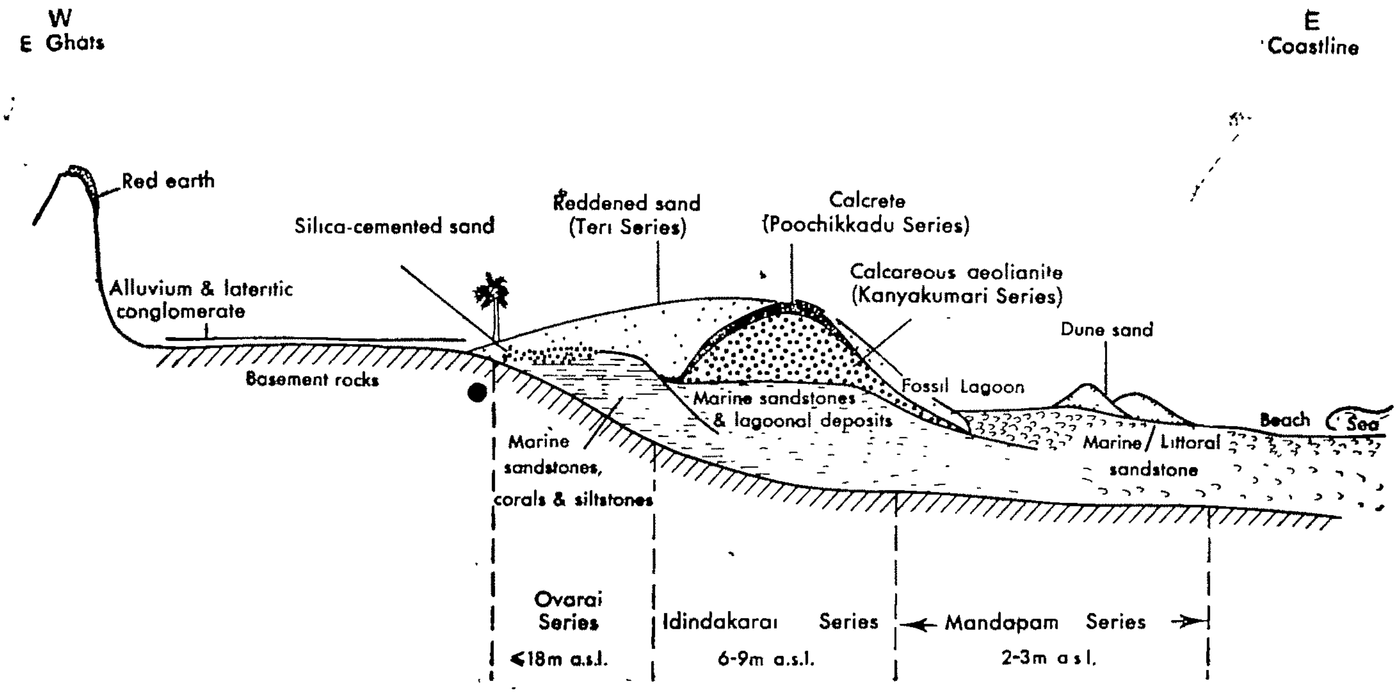

W
E Ghats
E
Coastline
Red earth
Alluvium & lateritic conglomerate
Basement rocks
Silica-cemented sand
Reddened sand (Teri Series)
Calcrete (Poochikkadu Series)
Calcareous aeolianite (Kanyakumari Series)
Dune sand
Fossil Lagoon
Marine sandstones & lagoonal deposits
Beach
Sea
Marine/ Littoral sandstone
Marine sandstones, corals & siltstones
Ovarai Series ≤18m a.s.l.
Idindakarai Series 6-9m a.s.l.
Mandapam Series 2-3m a.s.l.

Fig. 15.

probably deposited at the shoreline at the same time as the underlying nearshore/beach sediments (Idindakarai Series), since there is no evidence of an unconformity between the two, and the dunes do not exist over the fossil lagoonal sediments. Thus, the subaerial cementation of the marine and aeolian sands may have taken place simultaneously, following deposition of the dune sands. The calcrete formed on and within the exposed surface of the aeolianite and marine deposits just prior to the peak of the last glacial, and was followed by deposition, on a large scale, of coastal aeolian sands. These were subsequently weathered to a depth of 10 m and more, forming a matrix of hematite, kaolinite and illite, and possibly releasing opaline silica for reprecipitation lower down the profile. During the mid-Holocene, marine sediments of the Mandapam Series were deposited up to 3 m above present mean sea level. As with all the other deposits, the clastic sediments were derived from the Archean rocks of the coastal plain and the Ghats mountains. Thus, the coastal stratigraphy and development as outlined above differs markedly from the earlier proposal of Zeuner and Allchin (1956; Figure 3).

The complete sequence of sediments was not observed in all areas, as shown in the selection of simplified sections in Figure 16. For example, the Mandapam and Rameshwaram Peninsula (section 1, Figure 16) comprises entirely Holocene sediments; mostly lagoonal and high energy facies, with localised patches of coral reefs. The exposed marine sediments are partially to well cemented by $CaCO_3$ but the dune sands remain uncemented. Near Valinokkam (section 2) there is a broad expanse of Holocene nearshore sediments and a modern sandy spit sheltering the lagoon. Further inland the basement rocks are overlain by the Idindakarai Series (high energy facies), aeolianite (Kanya Kumari Series), calcrete (Poochikkadu Series) and teri sands, some of which have been washed over onto the edge of the Holocene sediments.

Just to the south of Tuticorin (section 3) the Ovari and Idindakarai Series can be seen, but the Kanya Kumari Series is not well represented. The marine sediments are overlain by a thin cover of teri sands, and in places the reddening process has continued into the upper layers of the marine deposits. The Pleistocene

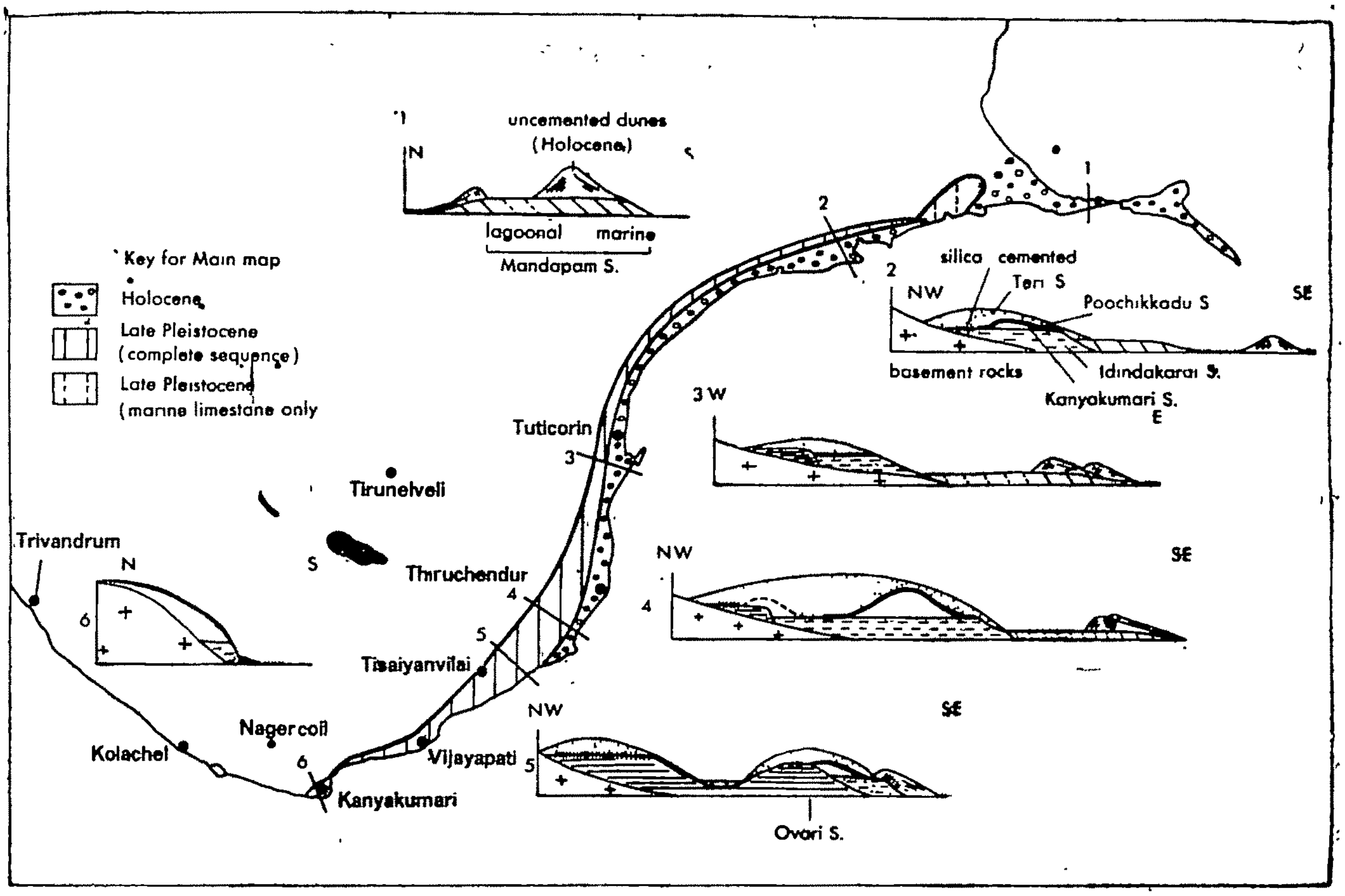

1
N
uncemented dunes
(Holocene)
S
lagoonal
marine
Mandapam S.
Key for Main map
Holocene
Late Pleistocene
(complete sequence)
Late Pleistocene
(marine limestone only
2
1
2
silica cemented
Teri S
NW
Poochikkadu S
SE
basement rocks
Idindakarai S.
Kanyakumari S.
E
3 W
Tuticorin
3
Tirunelveli
Trivandrum
N
S
6
Thiruchendur
4
NW
SE
4
5
Tisaiyanvilai
NW
SE
Nagercoil
Kolachel
6
Vijayapati
5
Kanyakumari
Ovari S.

Fig. 16.

sediments are fringed to the seaward by lagoon and high energy marine deposits of the Mandapam Series, and modern/Holocene dune sands. Section 4 is the classic sequence, found over much of the field area.

Section 5, near Tisaiyanvilai, represents a small part of the coastline, the most complex, where the Ovari Series is most widespread. Here, the reef facies occurs to the seaward of the high energy facies. The Idindakarai Series and aeolianite with calcrete capping are relatively limited in extent. Teri sands overlie all the older sediments, and in this area silica diagenesis is common in the base of the teri sands and the upper parts of the underlying, weathered Ovari sediments. A seasonal stream drains through the area, separating the deposits into two distinct units. Holocene Lagoonal sediments (Mandapam Series) are found in the lower reaches of this broad valley, and Holocene and modern dunes overtop the teri sands along the exposed coastline. At Kanya Kumari (section 6) the basement rocks, descending from the southern tip of the Ghats, have been cliffed by the sea and Idindakarai high energy deposits plastered against them. Aeolianite, banked against the rock face, overlies the marine sediments, and is capped by a thin laminar calcrete crust. This crust has been lightly weathered in places but Teri sands and Mandapam Series sediments are absent from this exposed and eroding shore.

ACKNOWLEDGEMENTS

The research was undertaken whilst the author was in receipt of a NERC Research Studentship. Thanks are extended to Dr. A. S. Goudie, the Drawing Office staff in Dept. of Geography, King's College, the British Council in Madras, the Courts, the Roper-Evans and Roy Nissen.

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Wood Remains from Archaeological Sites

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INTRODUCTION

During last few decades the techniques for handling the archaeological material have improved considerably owing to advancement in natural sciences. Archaeological materials are now subjected to microtomy, maceration and other physical, chemical and biological tests which lead to their correct identification (Chowdhury, 1968, Buth, 1981).

Although charcoals form a very important constituent of the plant matter recovered from the archaeological excavations, yet very little attention has been paid towards the identification of wood remains as compared to seeds, grains etc. The study of the charcoal remains is very significant as it provides information on past vegetation and palaeo-environmental conditions prevailing during the period of occupation. The study also provides some eloquent clues regarding the rituals that the inhabitants might have been performing as a part of their religious belief.

There is substantial evidence that our early ancestors were well aware of the best wood for burning, for warmth or for metal smelting ; those most durable and strong for making boats and buildings, and those suited as shafts for tools and weapons (Cutler, 1978).

The present paper reviews the work done on wood remains recovered from archaeological sites and their significance in the history of vegetation and culture,

Archaeological Woods

The evidence for the use of wood is available only in the late Palaeolithic age. Men of Clactonian culture of England have been found to use 'Yew' (*Taxus* sp) wood for spear. About the same time wood has been found to be used in Germany (Hawkes and Woolley, 1963) where the entire spear made of wood was found inside the skeleton of an elephant. No such evidences are available from the Indian region.

The oldest archaeological wood remains recovered from the Indian region are those from the full-fledged bronze age civilization of Harappa (2300-1750 B.C.). The timbers used for a coffin were identified as deodar (*Cedrus deodara*) and rose-wood (*Dalbergia latifolia*) (Chowdhury & Ghosh, 1951). Their presence at Harappa has raised some interesting points. Firstly, these trees do not, at present, grow near about Harappa, nor could they have been growing during the Harappan civilization. Rose wood trees are now growing at a distance of 525 km south wards from Harappa (Champion and Seth, 1968). Thus rose wood was obtained from Harappan settlements of Rajasthan and Gujarat which are miles south of Harappa (Vishnu Mittre 1967-68). As regards deodar, it could not have grown at a low elevation at the time of Harappan civilization because the last phase of glaciation was over long before the time when the Indus Valley Civilization existed (Chowdhury 1968).

Archaeologists have already gathered evidence of communication links between the hills of Kashmir and this civilization which lies in close proximity of the valley (Buth and Kaw, 1984). The wood might have been obtained from the hills of Kashmir for making coffins.

Another interesting point is that the two timbers used for coffin-making were scented woods. Use of scented woods for making coffin has long been known to be the practice in Iraq and Egypt. The presence of a single coffin burial at Harappa supplies additional proof of contact between Harappan civilization and Iraq (Chowdhury, 1968).

The other important timber recovered from this excavation was ber (*Zizyphus* sp.) which was used as a mortar for pounding grains. This tree grows round about Harappa and might have been collected locally. Use of this timber reveals that the Harappans had a keep knowledge of seasoning properties of woods and shock-absorbing property of ber (Chowdhury & Ghosh, 1951).

Atranjikhera is one of the few sites with the chronological succession from 2,000-50 B.C. From palaeobotanical point of view it is very significant. The charcoal remains from various phases of this site were identified as *Pinus roxburghii* (Chir) ; *Cedrus deodara* (deodar), *Cupressus torulosa* (Cypress) ; *Dalbergia sissoo* (sissoo) ; *Shorea robusta* (sal) ; *Acacia nilotica* (babul) ; *Tectona grandis* (teak) ; *Terminalia tomentosa* (laurel) ; *Tamarix articulata* (farash) and *Dendrocalamus strictus*. The archaeological and botanical importance of these wood remains has been discussed in the book "Ancient Agriculture and Forestry in North India" (Chowdhury, Saraswat and Buth, 1977). Present day distribution of these plants indicates that only babul, laurel and farash appear to be local timbers and other might have been brought to Atranjikhera from long distances. Chir might have been brought to the Ganga valley from the hills of north ; sissoo from Nepal and Duars, Sal from eastern region, teak from peninsular India and deodar and cedar from hills of north. This leads to think that even 4,000 years ago there was existence of some sort of trade between different settlements in the plains of India. Or else some among these settlers may have come to Atranjikhera from the areas where these trees form virgin forests and they have brought the timbers along with them. Regarding the possible uses of these trees, *Pinus* could have been used at the early stage of economy for house posts. Sal and teak might have been used for constructional purposes. Secondly the scented woods possibly might have been used for some religious rituals. Other woods were probably used as firewood or charcoal (Chowdhury et. al. 1977).

The wood remains recovered from the Neolithic site of Burzahom in Kashmir (2325-1500 B.C.) were identified as belonging to *Pinus* sp. *Betula utilis*, *Salix* sp. and *Ulmus* sp. (Buth and Kaw, 1984). Pine does not grow at present anywhere near Burzahom and evidently must have been transported from the high mountains by the ancient inhabitants. The discovery of birch (*Betula utilis*), which is an alpine species growing in the Himalaya at 14,000 ft. (Watt. 1966), is very significant. Birch is growing at Mahadeva Tirtha, 25 kms towards east of Burzahom and might have been collected from there. The inhabitants were using the bark of birch for roof thatching. *Salix* and *Ulmus* were used as fuel or firewoods. Pine was mostly used for house posts.

Vishnu Mittre (1974) reported *Saccharum spontaneum* from Chirand, Bihar (1800 B.C) which was probably used for basketry and matting. From Hallur, Mysore (1800 B.C.) Vishnu Mittre (1971) reported the occurrence of *Tectona grandis* and suggested the prevalence of a climate not so dry as today in the area. The boles of teak might have been used as poles by the ancient inhabitants.

From Lothal, Gujarat (1700 B.C.) wood remains of *Acacia* sp. *Albizzia* sp. *Tectona grandis*, *Adina cordifolia* and *Soymida febrifuga* have been reported. These woods were used as firewood by the ancient inhabitants of Lothal (Rao and Lal c.f. Chowdhury, 1974).

Prakash and Awasthi (1957-59) identified Acacia, bamboo, and two unidentified dicot and one conifer wood from Navdatoli (1660 B.C.-1400 B.C.). The conifer might have been transported either from Himalayas or from Nilgiris. Rao and Sahi (1967) reported *Tectona grandis* ; *Acacia* sp. *Anogeissus* sp. *Holarrhena antidysenterica*, *Dalbergia latifolia*, *Terminalia* sp. and *Demdeocalamus* sp. from Prakash, Maharashtra (1700 B.C.-600 A.D.). These woods were believed to be used as fuel woods for constructional purposes, furniture, and agricultural implements like ploughs, carts etc.

Buth and Bisht (1981) and Buth et al. (1982) recovered remains of blue pine (*Pinus wallichiana*) from Semthan, Kashmir, (1200 B.C.) which was used as a building material.

The ancient inhabitants of Hastinapur of copper age civilization (1000 B.C.-500 B.C.) were well acquainted with the high caloric value of woods like *Dalbergia sissoo* and *Holarrhena antidysenterica* as evidenced by the occurrence of their wood remains from the site. Also identified from the site were the charcoals of *Saccharum spontaneum* (Chowdhury and Ghosh, 1954-55). Chowdhury and Ghosh (1957) also identified the charcoal remains of *Acacia* and *Chloroxylon swietenia* from Maski in Mysore (1000 B.C.-100 A.D.). Vishnu Mittre (1966) reported bamboo from Kaundinyapur (500 B.C.).

Chowdhury and Ghosh (1952) reported *Acacis* sp. *Boswellia serrata, Casearia* sp. *Holarrhena antidysenterica* and *Soymida febrifuga* from Sisupalgarh, Orissa (200 B.C. 200 A.D.). These were used as firewoods and charcoals.

Ghosh and Lal (1958) reported *Shorea robusta* from Mauryan Pillared Hall, Patliputra (100 B.C.). The wood was used as a palisade against erosion by Ganges. The woods of *Shorea robusta, Terminalia tomentosa, Mangifera indica* and *Chinnamomum tamale* were used as firewood and also for the Asvamedha ceremony by the inhabitants of Kalsi near Dehradun (Ghosh and Lal 1961). Ghosh and Lal (1962-63) reported the remains of *Acacia* sp. *Albizzia* sp. *Petrocarpus santalinus, Soymida febrifuga, Melia* sp. and *Tamarix* sp. from Rangpur.

Vishnu Mittre, Prakash and Awasthi (1971) recovered charred remains of bamboo, *Sonneratia* sp., *Terminalia* sp. *Tectona* sp., *Boswellia* sp. from Ter, Maharashtra (150 B.C. to 260 A.D.). These woods were probably used as fuel or for constructional purposes and indicate the existence of a dry deciduous forest community in the vicinity of Ter.

Chowdhury and Ghosh (1946) reported wood remains of *Diospyros* sp. *Mimusops* sp., and *Heritera* sp., from Arikamedu, Tamil Nadu (100 B.C.-200 A.D.) These woods were perhaps used as toy boats and legs of cot or stool etc. Ghosh (1950) identified *Madhuka latifolia* syn. Bassia *latifolia* remains from Kirari (M.P.) used for a pillar found in the bed of an old tank.

The study of wood remains from gem pits of Sabaragamuva province of Ceylon have revealed *Mesua* sp. and *Lagerstrornia speciosa.* These were deposited by periodic floods some 47,000 and 7,520 years ago along with the precious stones which are now being commercially exploited in Ceylon (Chowdhury 1965 a).

Chemistry of the Archaeological Woods

Archaeological woods have also been studied to know the rate of disintegration, deteroration, degradation and behaviour on chemical treatment. Chowdhury (1935) reported that Indian timbers can survive the conditions of burial underground or exposure only to exigencies of atmosphere for many hundreds of years without any sign of serious deterioration visible under the light microscope; though in older woods, particularly the wood fibres show extensive breakdown, Gortner (1938) reported on chemical analysis of some glacial woods, an increased ash content with age burial which may be due infiltration of inorganic salts from the earth. Pentosans and cellulose decrease with increase in age of the wood while lignin shows an apparent decrease. These observations were confirmed by Barghoorn and Spackman (1950) and Barghoorn (1952) using both lignites and archaeological materials. They found that middle layers of secondary wall is first affected, while the inner and the outer persist.

Sen (1956, 1960) and Sen and Basak (1957) reported similar findings with some other ancient woods. Chowdhury (1950) reported that even after 20 million years the vertical parenchyma cells may still survive. Chowdhury, Ghosh, Bhat and Vyas (1957) studied the difference in the behaviour of tissue in ancient plant remains and found that parenchyma cells and rays are usually found to retain their original structure better than the fibres. Chowdhury, Preston and White (1967) studied the structural changes in some ancient Indian timbers and reported that burial underground leads to a progressive reduction in the amount of cellulose present. Amorphous cellulose is rapidly degenerated while the crystalline decays more slowly.

Woods in Ancient Indian Literature

Mackay in "Mohenjodaro and the Indus Civilization" (Ed. Marshall, 1931) reported the plant forms represented on the seals from Indus Civilization. Some of these plants identified were Pipal (*Ficus religiosa*) Babul (*Acacia arabica*) and Jandhi (*Prosopis spicigera*) trees. According to him tree worship particularly of Pipal and Banyan was probably common in this civilization as well as is true for other ancient religions of the world.

Besides the information available from archaeological materials, there are considerable references in the ancient Indian literature on the uses of wood. Certain timbers were specifically recommended for making the thrones of kings while others were tabooed. There is mention of people using boats and ships for commercial as well as pleasure purposes. Instructions regarding selection and handling of various woods for boat and ship building are also given. This leads to the fact that experiments must have been carried out for years for drawing such conclusions. There is an interesting record of the existence of a class of craftsmen in the society known as "Vadhaki" or Carpenters. Thus it is clear that if Vedic age claims priority for the knowledge of the rotation of crop plants, there is now enough data available to show that the people of India of a much earlier age could claim priority to a sound knowledge of efficient use of wood utilization (Aiyer, 1949, Majumdar 1951, Chowdhury and Ghosh, 1958, Bloomfield 1964 : Kapil, 1970).

CONCLUSION

It is not definitely known when man first began to use wood. There is, however, a general belief that this practice started during the Old Stone Age, when man was on the look out for digging tool in his search for food (Hoebel, 1949). During this age he also probably learnt the use of fire for which wood was necessary. Actual evidence for the use of wood by man has come from the excavations of the sites of New Stone Age (Hawkes and Woolley, 1963). In the Indian subcontinent no site of Stone Age has so far yielded any evidence of the use of wood (Chowdhury 1965b, 1970). Our earliest record, as is clear from the given account, goes back to protohistoric period to historic era when we find men of Indus Valley Civilization using wood for many purposes.

The variety of uses to which wood has been put by the ancient inhabitants of Harappa, Hastinapur, Atranjikhera, Burzahom and other ancient sites, leads one to infer that experience of thousands of years must have been behind the people of these ages to give them such an insight into the properties of different timbers.

There is enough proof, based on the remains of wood recovered from excavation of ancient sites to show that the people of the past civilizations had a good knowledge of selection of various timbers for specific uses and location of the forests from where the best quality timbers of different species could be obtained.

ACKNOWLEDGEMENTS

Thanks are due to U. G. C. for providing financial assistance and also to Head, Department of Botany, for providing necessary facilities.

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Assemblage Comparison : A Note of Caution

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INTRODUCTION

Comparative analysis of assemblages of stone artifacts has been usually based on the characteristic features of flint-knapping technique, typology and stratigraphy. In the absence of the latter i.e. stratigraphical evidences, obviously it is generally done in relation to the former two factors : the flint-knapping technique and the typology.

Raw material is one of the important elements of flint-knapping technique, but curiously enough it is normally omitted in the course of between assemblage analysis of flint-knapping technique. The said element not only causes difference in the selection of fabricator and technique, but sometimes also in tool types. It is found that analysis refer 'crude heavy biface' or 'fine heavy biface', perhaps, without taking into account above mentioned element and moreover they interpreted assemblages as early or late.

A number of scholars like Burkitt (1963), Sankalia (1964), Crabtree (1967b, 1972), Crabtree and Gould (1970), Bhattacharya (1972, 1979), Oakley (1975) have summarised most of the flint-knapping techniques and needless to repeat here. Moreover, authors such as are Crabtree and Butler (1964), Rinehart (1964, 1966), Cotterell (1968, 1970, 1972), Faulkner (1972), Speth (1972, 1974) also tried to study the mechanics of stone fracture, All these and other studies suggested how different types of stone flakes, blades and tools like handaxe, chopper/chopping, scraper, burin, point, triangle, lunate, trapeze, micro-burin, etc., would have been made.

Possible causes of variability among assemblages belonging to similar tradition include cultural, stylistic, functional, temporal or sampling error. Besides these, scholars also argued about the variability caused by raw material in the archaeological assemblages collected from different sites (Crabtree, 1967a ; Clark, 1980 ; Straus, 1980). It has been noticed by authors that a change in fabricator or mode (cf. Newcomer, 1975) also make a change in the shape and size of flakes/flake scars (Crabtree, 1967b, 1972 ; Newcomer, 1971, 1975). It is also observed that similar flakes/flake scars can be produced by different fabricators and to know about fabricator requires a number of experiments on the same raw material by different fabricators (Newcomer, 1975).

In the light of above observations and suggestions a series of experiments were carried out by the author (Sinha, 1984a). Here, an attempt has been made by the author to replicate a few stone artifacts of Lower Palaeolithic period. The purpose of replication is to demonstrate the role of raw material and fabricator in the study of lithic technology and assemblage variability. The artifacts replicated are handaxes, cleavers, knives, scrapers. spheroids and flakes (Plates—I, II). Raw materials used for the experiments include sandstone, quartzite, chert, lime stone and flint, and fabricators involved in the direct percussion technique comprise of stone hammer, light-stone hammer with rounded ends and antler.

Big flakes were removed from the boulders or cobbles either by block-on-block technique or by direct stone hammer percussion technique. The selection of technique was dependent upon the size of the primary form of raw materials. Thereafter, flakes of required dimensions were removed by stone hammer through direct percussion technique.

Handaxes and knives were made on flakes and were bifacially retouched either by stone hammer or rounded light stone hammer and/or antler (Plates—II : 1, 2, 3 ; IV : 1). During replication of handaxes and knives a number of flakes of various dimensions (debitage) came out including typical biface trimming flakes (Plate—II : 4).

Cleavers were made by flake-cleaver technique using stone hammer or rounded light stone hammer and/or antler. Flake-cleavers were obtained by the intersection of the distal portion of the previous flake scars and the primary flake surface. The former surface was used for the dorsal distal face of the flake-cleaver (Sinha, 1984b ; Plate—III). In the course of bifacial retouching of the lateral sides and butt end a number of flakes of various dimensions (debitage) including typical biface trimming flakes came out (Plate—II : 4).

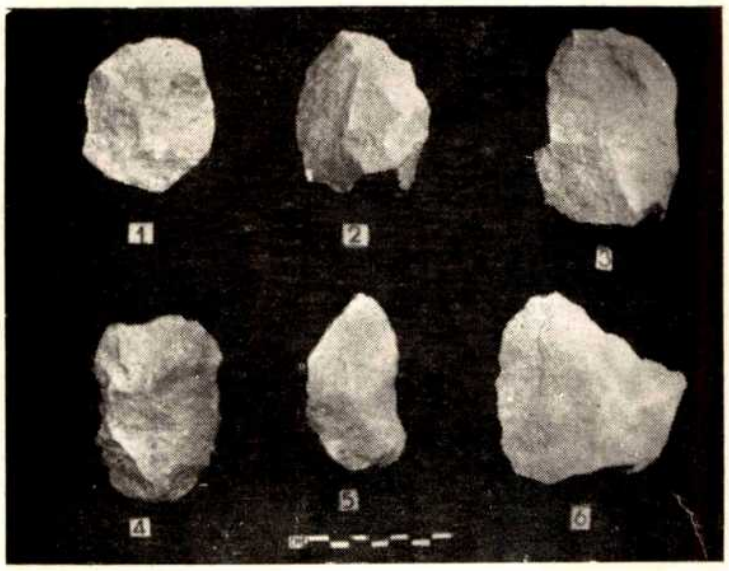
Scrapers and spheroids were made on flakes or chunks by stone hammer or rounded light stone hammer and/or antler (Plate—I : 1, 2, 3, 5). During the process of unifacial retouching flakes came out though, a few in numbers in comparison to flakes in the manufacture of handaxes, cleavers and knives and no typical biface trimning flake was present among these small flakes (debitage).

The following observations have been made in the course of experiments regarding raw materials, fabricators and debitage :

1. Flakes/flake scars produced by stone hammer (Plate—IV ; 2) to some extent are distinguishable from those produced by rounded light stone hammer and antler (Plate—IV : 3, 4).
2. Flakes/flake scars produced by rounded light stone hammer and antler are hardly possible to distinguish and, require a series of experiments and/or observation under microscope for micro-wear traces (Plate—IV : 3, 4 ; Sinha, 1985).
3. It is very difficult to remove regular and uniform flakes on coarser raw material such as sandstone.
4. It is very hard to make fine and thin artifacts on coarser raw materials and distal end of some tools like point, picks, etc. This is probably because of big grain sizes of such raw materials and low flexibility and often they break in the process of finer retouching.
5. Generally, flakes scars on lime stone have relatively more prominent positive or negative bulb of percussion than those produced on other raw material used in this research (compare Plate—IV : 1-4 and Plates—I, II : 1-4).

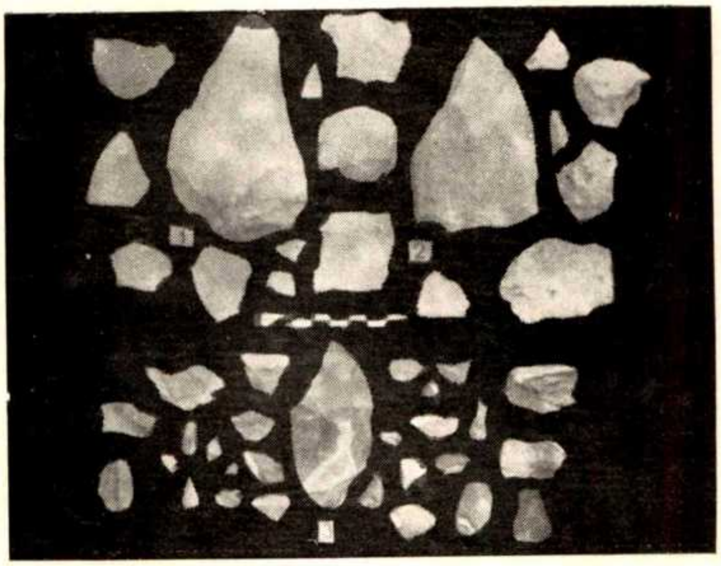
In the light of above observations the following conclusions can be made.

1. The raw material is relatively more important element than the fabricator in the study of lithic technology.
2. Crude or fine appearance of tools does not merely depend upon the workmanship but also on the type of raw material used for manufacturing artifacts. One more explanation is also possible in Binford's terminology (1973) that crude tools may generally have been "expedient" tools, whereas many of the fine tools may have been "curated" tools. However, this explanation needs further systematic explorations and experiments.
3. It may be possible that an assemblage fashioned on coarser raw material consists of a low frequency of some tools like pick, point, etc.
4. A detailed study of raw material, debitage and flake scars on tools and cores should be made



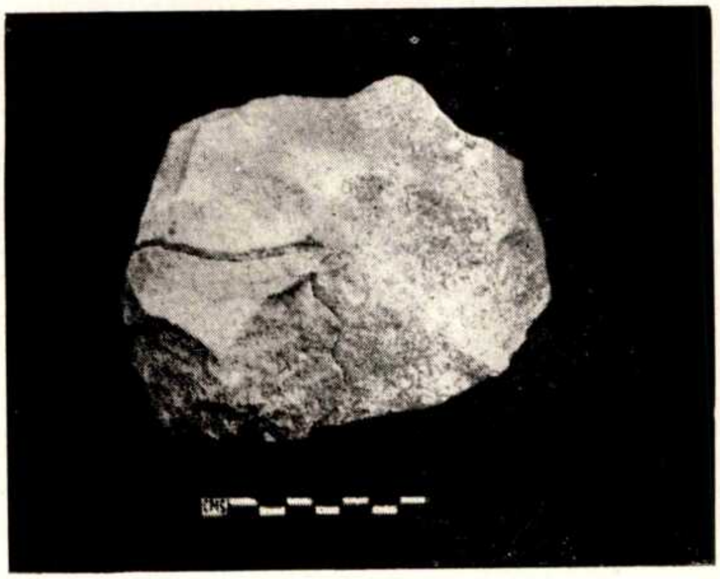
Prakash Sinha : Plate I

1. Spheroid, sandstone, hammer stone.
2. End and Side scraper, sandstone, hammer antler.
3. Rounded scraper, sandstone, hammer stone.
4. Quarilateral flake-cleaver sandstone, hammer rounded light stone.
5. Single side scraper, sandstone, hammar stone.
6. Unmodified flake, sandstone, hammer stone.



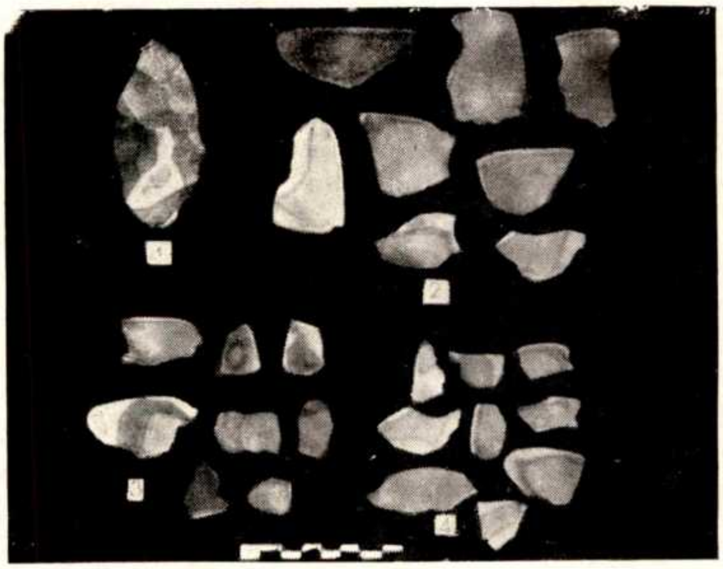
Prakash Sinha : Plate II

1. Triangular handaxe, sandstone, hammer : antler.
2. Side knife, sandstone, hammer : rounded light stone.
3. Ovate handaxe. limestone, hammer : antler.
4. Rest are small flakes (debitage) came out in process of final retouching, also include biface trimming flakes above the scale of sandstone and below the scale of lime stone.



Prakash Sinha : Plate III

Detached primary form of flake-cleaver (flake) on core, sandstone, hammer : stone.



Prakash Sinha : Plate IV

1. Ovate handaxe, lime stone, hammer : antler.
2. Group of flakes, lime stone, hammer : stone, bulbar aspect.
3. Group of flakes, lime stone, hammer : rounded stone hammer, bulbar aspect.
4. Group of flakes, lime stone, hammer : antler, bulbar aspect.

before claiming about the probable flint-knapping technique of an assemblage.

5. It would not be proper to assign the assemblage earlier or later merely by making technological comparision with other assemblages fashioned on different raw material.

To sum up it may be said that while making assemblage comparision the analyst should keep in mind the above mentioned facts which may lead him towards a proper, systematic and scientific conclusions.

The author is grateful to Shri Sanjay, Department of Ancient History, Culture & Archaeology, Allahabad University for the preparation of photographs.

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Iron Tools, Forest Clearance and Urbanisation in the Gangetic Plains

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INTRODUCTION

In the context to urbanisation in the Gangetic plains during the middle of first millennium B.C. it has been repeatedly argued by some archaeologists and historians that the urbanisation was possible only because of widespread use of advanced iron tools which helped the people in clearing the then dense monsoonal forest of the Gangetic plains and wide-spread use of iron tools was possible only when Bihar ore mines could be exploited in the middle of first millennium B.C. (Agrawal 1969, 1971 ; Banerjee 1965 ; Deva 1973 ; Joshi 1974 ; Sharma 1965, 1973, 1983). However, some scholars argued that it was not the technology alone but the establishment of strong social and political institutions which brought the urbanisation at home (Chakrabarti 1973a, 1973b ; Ghosh 1973 ; Ray 1978). Ray (1978 : 134) said that slowly and steadily forests were cleared for the habitation and agricultural purposes and there is as yet no absolute cause for iron technology effecting the clearance of forests. Present writer's interest in the settlement patterns and systems in the Ganga plains during the second and first millennium B.C., first hand knowledge of the setting of archaeological sites, excavated archaeological materials and intensive explorations in the Ganga plains lead to the conclusion that the so called extensive use of iron tools and the large scale forest clearing for human settlements and agricultural land is nothing but a myth. The problem of clearing of forests for human settlements and agricultural land and a few references found in literature *viz. Satapatha Brahamna,* have been blown out of proportion. A careful analysis of archaeological data, location and density of settlements, an approximate estimate of population on the basis of size of settlements and an idea of land requirement for the agricultural purposes to support the population are bound to give us a fairly good idea about the problem of large scale use of iron tools, deforestation and urbanisation.

In the present paper I propose to discuss these problems in four parts. The part I gives an idea of flora of the upper Ganga plains as it is today and what it may have been in the past. In part II, iron technology and the frequency of tools in PGW and NBPW periods have been discussed. The part III deals with the colonisation and the density of settlements during NBPW period in upper Ganga plains. In part IV taking a maximum population in the village or a settlement its land requirement has been computed on the basis of need of foodgrains and the yield per acre and lastly the actual forest clearing that may have taken place during the middle of first millenninm B.C. Taking into consideration above factors conclusions have been drawn about the urbanisation in the Gangetic plains.

I

Forests of the Gangetic Plains

The vast alluvial plains of northern India as we see them today are the result of continuous deforestation for the last four millennia. In the traditional literature we have ample evidence for the Gangetic plain being covered with dense monsoonal forests. The *Satapatha Brahmana* (14.1.4.14,15,16) mentions that area between Saraswati and Sadanira (modern Gandak) river was dense forest and aryanisation of this area was possible only after burning of the forests. According to *Mahabharata* Hastinapur the capital of Kurus was situated in a forested area. It also mentions that the kingdoms of Kurus and Panchalas—covering roughly the upper Gangetic plains—were located in forested area. *Devipurana* (Chapter 14) mentioned nine secred forests of which Kuru Jungle, Nimisa (Naimisaranya) and Utpalaranya covered the upper Ganga plains. Naimisaranya has been identified with modern Nimsar, 20 km. northwest of Sitapur. This was the forest where several thousand sages lived and many *Puranas* were written. Utapalaranya was the forest where sage Valmiki lived and Sita gave birth to twins known as Lava and Kusha. This place is identified with modern Bithur, 20 km. north of Kanpur where there is still a Valmiki Ashram.

Pollen records from Hastinapura excavations show the presence of *Pinus, Dalbergia sissoo*, and *Holorabera antidysentrica* (Chaudhury *et al* 1977, Lal 1954-55 : 120). Samples of charred wood from OCP to NBPW levels at Atranjikhera belong to *Pinus roxburghii, Dalbergia sissoo, Tectona grandis, Boehmeria platypyla, cedrus deodara, Cupressus torulosa, Terminalia tomentosa, Tamarix articulata. dendrocalamus strictus, Acacia nilotica* and *acacia arabica* (Chaudhury *et. al.* 1977). The presence of these species some of which are now confined only to the *Tarai* region shows that the doab was then quite densely forested during the second and first millennium B.C. Pant says (Agrawal 1977 : 225) that in the past the fauna of Siwaliks included carnivores, monkeys, elephants and ungulates suggesting that the Indo-Gangetic plains had a thick cover of flora like that of *Tarai* and *Bhabhar* regions. In fact, the forest cover was so thick even in the 15th and 16th centuries A.D. that wild elephants buffaloes, lions and tigers were hunted in the upper Ganga plains (Abul Fazal, *Ain-I-Akbari*, pp. 283-93). But now the once rich and varied fauna has been reduced to small number of deer, antelopes, boars, hyenas, wolves, foxes, jackals and monkeys.

The remnants of early forests can be seen in the patches and the vegetation includes *Butea frondosa, Caserica tomentosa, Alienthus excels, Woodfordia floribunda, Acacia laucophoria, Terminalia belerica, Tamarind us indica, Basia latifolia*, and species of *Bauhinia* and *Eugenia* (Puri 1960 : 212). *Bombax malabaricum, Adina cordifolia, Lagerstroemia perviflora, Lannea grandis, Gamalina arborea, Casia fistula, Mallotus philippinensis* and *Calicarpa microphyla* are now confined to the most part of the sub-Himalayan tract (Puri 1960 : 251). In the central part of the Ganga-Yamuna doab thorny shrubs such as *Caparis aphylla, Prosopi spicigera, Tecoma undulata* and *Salsola kali* can be seen along with the species of *Grevia* and *Acacia* which form an extension of semi arid vegetation of Rajasthan.

In fact no other part of India has undergone such a drastic change due to tillage of jungle land in the past two centuries. Considerable damage to the forests was done by the railways also which obtained their fuel supply directly from local timber until a century ago (Whitecombe 1972 : 95). The intensive colonisation and large scale deforestation has brought the balance between man and vegetation to a very delicate stage. Mukharjee (1938 : 97-103) sums up :

> "Nowhere is this interaction between man and vegetation so vividly illustrated over an extensive area than in the Gangetic plains. The balance between the progressive tendencies of vegetation and retrogressive influence of man is no where more evident than in the vegetation of this region. Throughout the Gangetic plain may be said to have attained an apparent equilibrium in relation to variation in rainfall and temperature which at any moment is liable to be upset...On the plains the vegetation is rather delicately balanced against man at about thorn-scrub state. The soil over most of the Indo-Gangetic plains seems to be supporting all the human and bovine life that is possible under existing methods of exploitation."

Thus it is very clear that until during the beginning of centuries A.D. the forests were almost undisturbed except for small pieces for the land that might have been required for the agricultural purposes and for the settlements. The presence of lions, tigers, elephants etc. even until 16th century indicates that forest was fairly intact and well preserved. As a matter of fact the forests disappeared rapidly only in the last two centuries.

II

After having an idea of the types of forests we had in the Gangetic plain in this section we shall consider the typology and the frequencies of iron tools found in PGW and NBPW period to see if there is any difference between the two as it has been often postulated that it was with the use of new type of iron tools at a large scale NBPW people cleared the forests for extensive agricultural purposes which lead to urbanisation.

The champions of the view that there has been fundamental changes in iron technology and tool typology from PGW to NBPW period and it was after the opening of Bihar ore mines the iron tools came to be extensively used never give any concrete evidence in support of their view. It is my feeling that most of such opinions have been expressed on incomplete informations and many presumptions.

First of all let us accept the fact that after the publication of Hastinapura report not a single excavation report came out from where a comparative picture of PGW and NBPW periods could be drawn. Fortunately, now we have Atranjikhera excavations report with full details about every iron piece found in PGW and NBPW periods. We are really in good position to draw a comparative picture of iron tools typology, technology, its use and its extensiveness.

The table 1 shows the various tool types and other objects found in PGW and NBPW periods. The total area excavated for PGW is about 1,000 sq. m. (Gaur 1983 : 122) while that of NBPW is more than double (personal communication). In all there are 16 types of objects in PGW with a total of 135 pieces and there are as 303 pieces in NBPW period. From this total if we remove slag pieces and the lumps then we are left with 114 pieces for PGW and 252 pieces for NBPW period. The 15 new types that have been introduced in NBPW period mostly do not come in tools category and also they number 43 only. Also another fact is that most of these were introduced in Phase B and C which are dated between 500 and 200 B.C. i.e. when the urbanisation was already an established fact. It may be emphasized that all the forest clearing tool kit was very much there in the PGW period and there is no appreciable change in their number from PGW to NBPW period. Though the number of iron tools in NBPW is almost double but when we consider the fact that the excavated area was also almost double and the smaller objects like nails etc. have increased the number, we find that there has neither any change in technology nor in the extensive use of tools ; only its ghost has always haunted us.

Also the upper Ganga plains did not have to look towards Bihar ore mines to be opened as late as 5th-6th centuries B.C. for the extensive use of iron tools and implements. The presence of iron objects in such profusion and the discovery of furnaces at Atranjikhera and Noh and certain specific tools used by black-smiths at Atranjikhera make it very clear that not only iron tools and other objects were manufactured here but also the smelting of ore was also done. The main source of iron ore was perhaps the region extending between Agra and Gwalior. The hills of this region are extremely rich in iron ore in which iron content is very high. The iron industry of Gwalior has been noted by Abul Fazal in his *Ain-I-Akbari* (ed. Blochman, p. 47). Sir Alexander Cunningham (1864 : 235) also commends the quality of Gwalior and Narwar iron and regrets the decline of the industry due to the scarcity of charcoal for smelting as the forests were being cut down.

Another fact towards which I would like to draw the attention of scholars is the location and frequency of NBPW settlements in U.P. and Bihar. In both the States combined there are nearly 500 settlements of which less than 100 are in Bihar and rest 400 in U.P. (Sharma 1983 : 113). All the sites in Bihar are located in Arah, Chhapra and Patna districts with a very few beyond this region. It is also evident that no NBPW site has been found in iron ore area. A detailed distribution map of NBPW sites according to their known size shows that there is no truth whatsoever, in the view that Bihar was the nuclear zone of NBPW culture. Also it should not be forgotten that in Bihar from none of the NBPW site any appreciable number of iron tools have been found and neither the sites in Bihar are older than those found in the Upper Ganga plains.

From the above discussion it is clear that the opinion that Bihar iron ore mines had a big role to play in urbanisation does not stand the scrutiny of evidence.

III

Evidence For Intensive Colonisation

To understand the settlement patterns and systems in the Upper Ganga plains over a period of nearly two thousand years i.e. in the second and first millennium B.C. a Ph.D. project was taken up by the present author (Lal 1982, 1984a, 1984b). To understand the pattern of the change and also the density of settlements we should have, if not total, near total number of settlements of the period concerned. To explore whole of the Upper Ganga plains is simply beyond the capacity and resources of a single explorer. Thus in such a situation a methodology was followed which is considered to be most reliable and ideal i.e. it was decided to go for sampling and explore an area which could represent the plain on a miniature scale. As the methodology and the general results have already been published (Lal 1984a, 1984b). I shall confine here myself only with the results for the NBPW settlements which are directly relevant to us here.

In an intensive village to village survey in Kanpur district 99 NBPW settlements were discovered. Of these 65 settlements are on the river and 34 are away from the rivers. The settlements on the river banks are located on the elevated land, obviously to remain away from the range of annual flood. River-wise distribution shows that there are 20 settlements on the Ganga, one each on the Isan and Northern Non, 4 on the Pandu 25 on the Rind, 2 on the Southern Non and 3 on the Yamuna.

The break-up of settlements according to size shows that of 99 settlements 41 are below 1.00 hect. and 40 between 1.00 and 2.00 hect. size. In other words there are as many as 81 settlements which were below 2.00 hect size and each could have accommodated not more than 500 people (for details see Lal 1984c). There are only 14 settlements which were between 2-4 hect. size i.e. having a population between 500 and 1,000 people. There are only 4 settlements which are above 4.00 hect in size and could have accommodated a population between 1200 and 1300 except in the case of Radhan where the resident population should have been more than 2000. This settlement is the biggest one found in Kanpur district. It is very apparent that most of the bigger settlements were located on the river Ganga along the banks of which open agricultural land, games and other habitational facilities were more attractive and profitable than on the other rivers or away from the rivers. The settlements away from the rivers are mostly smaller in size.

One of the most important factors that we have to keep in mind is that the average spacing between the two settlements during NBPW period was 9 km. though some times they were as close as 2 km. and as far away as 12 km.

IV

Now with a proper background of the location and density of settlements and the spacing between the two settlements we shall proceed to evaluate the land requirement for a settlement and what could have been a territorial limit for the settlements and the actual forest area that might have been cleared for human settlement and agricultural land.

Catchment and Exploitation Area of a Settlement

The concept of effective area being exploited by a settlement was first formulated by C. Vita-Finzi and Eric Higgs (1970) They used the term "Site Catchment Area" and defined it as "the study of relationship between technology and those natural resources lying within the economic range of individual sites" (Vita-Finzi and Higgs 1970). In other words the catchment area of an archaeological site is that area from which a site (more properly the inhabitants of a site) derive its resources. In broad outlines site catchment analysis delimits a territory or a set of concentric circles surrounding a site from where greatest quantity of resources were derived. The territory exploited from a site will vary according to a number of factors the most obvious among them being the nature of economy, the size of population and the characteristics of terrain. However, the most important aspect of this exploited territory both in theory and practice is the capacity of the human population to exploite an area effectively.

This effective exploitation has another facet. "Further the area is from the site, less likely to be exploited and less rewarding is its exploitation (unless it is particularly productive) since energy consumed in movement to and from the site will tend to cancel that derived from the resource" (Vita-Finzi and Higgs 1970 : 7). Chisolm's study of agricultural exploitation on the global level shows that "as the average distance increased, per hect. return declined" and it is exceptional for the farmers to travel more than 3-4 km. to their fields" (Chisolm : 1968 : 43-68 ; Table 2, p. 50).

In such a situation if we know the area and the land well, for a particular size of settlement population it would not be difficult to compute the food grains needed and agricultural land required.

In the case of district Kanpur on the basis of size of settlements I have attempted to compute the size of population that might have been there (Lal 1984c). Here I shall take the site of Radhan (see site No. 115 in Lal 1984c) as a model and try to compute the land requirement for the agricultural purposes.

At Radhan during NBPW period a maximum population that could have existed at a particular time is around 2400 people. This figure should not be out of mark for a site which was 8.75 hect. in size.

Requirement of Food Grains

A variety of cultivars have been found in archaeological excavations of protohistoric and early historic sites in the Ganga plains. They include rice, barley, wheat, gram, lentils, millet and peas (Kajle 1974 ; Chaudhury *et. al.* 1977). Of these wheat, barley and rice must be considered staple food. In addition cattle, sheep and goat were the main source of milk and meat. Hunting and fishing must have also contributed to food economy.

Dhavalikar and Possehl (1974 : 41) have estimated the diet of an individual as follows :

> Minimum requirement for long term survival are about 1,700 calori per day taken with reasonably balanced diet. Good health can be achieved with about 600 calories more. Based on this fact the ethnographic record of somewhat modern comparable cultures the estimate presented here is for 2,000 calories. This figure has the advantage of being a mean estimate so that if it misses the resulting distortion would be minimized. The 2,000 calories have distributed as follows :

All grains	1,350	calories
Vegetables	100	,,
Meat (eggs and fish etc)	200	,,
Fruits and sweets	50	,,
Dairy products	300	,,
Total	2,000	,,

The content of 1 kg. grains is approximately 3,350 calories. Within the diet worked out here this would feed 2.5 persons for one day. By multiplying this with 2,400 (the estimated population of settlement) the daily grain requirement comes to 960 kg. which is daily food requirement. Multiplying this figure by 365 days we get 346,750 kg, which will be the yearly food grain requirement.

Land Requirement

It seems probable that there would be no spread of cultivation beyond the nucleus site before the evolution of cultivars capable of giving acceptable yield on less fertile and durable soils without seepage. This raises the question as to what may be an acceptable yield ? If we are to answer this question and other related to quantitative analysis we must make some assumptions and draw analogies from modern comparable examples. Archaeology does not provide us with basic data on yields of early cultivars or on the systems of field management, seed rates etc.

Grains and vegetables are the two main features of this diet which would require fair amount of farm land. For grains yields were computed for ten years from *fasali* 1305-1314 and taken from the *Gazetteer of Kanpur district* (1929). The average was combined and after deducting for seepage, regular seasonal disorder etc. the yield of 600 kg. per acre was arrived at (for details see Lal 1984a : 240-42).

The area required for the cultivation can now be computed from the yield per acre and the total grain requirement for one year. This comes to 578 acres. To this estimate something must be added for seeds, spilage, spoils, loss due to rodents and disease and processing. Vegetables, millet and pulses would require additional land. A figure of 0.25 acre per person satisfies the grain requirements. If 25% of this figure is added for vegetable crops (0.06 acre), 15% for loss (0.04 acre) and 15% (0 04 acre) for seeds the total land requirement comes to about 0.4 acre per person. By this estimate the total land requirement for 2,400 persons would be 960 acres. However, in this estimate no provision has been made for fallow land. If the land is left dormant every year it doubles the area required which is 1,920 acres and if the fallow period is of two years the land required would be 2,880 acres.

Before we express this land requirement in terms of radius around the settlement we have to consider one fact. On one side of the settlement is the river Ganga the bed of which is at places more than 3 km. wide. Between the settlement and the regular course of the river a strip of land of 150-300 and at places more than this comes up after the monsoon flood. This strip is rich in organic matter and very fertile. If we draw a circle around the settlement one-third of it would go in the river and not more than two-third will be available for the cultivation. Taking into consideration this fact when we draw a circle of land requirement around the settlement it comes to 1.8 to 2.6 km. in radius.

Similarly for a settlement of 1,000 population land requirement would be between 800 and 1,200 acres (1.3-.1.6 km radius), for a settlement of 3,000 population 2,400 to 3,600 (2.2-2.7 km. radius) and for a smaller settlement with 200 to 500 population the land requirement would be 250 to 1000 acres i.e. the land within a radius of 1 km. radius.

It may be pointed out that in Kanpur district, the total area of which is 6167 sq. km., maximum population that might have existed at any given time during NBPW period on 99 settlements was nearly 4,000. To support this population the land requirement was never more than 122 to 184 sq. km. (Lal 1984a : Table 49, pp. 244-47) and most of this land was available on the soft alluvial soils along the rivers and lakes and other open areas in the forests.

Actual Forest Clearings

Now we shall turn our attention towards the forest clearings that might have been done to aquire agricultural land. As we have already seen a good number of settlements are located on the rivers and lakes along which open spaces are available for the settlements and agricultural land. Even deeper into the forests we find that there are lakes and open spaces where settlements come up without disturbing the original forest[1]. Also in the case of NBPW we know that average spacing between the two settlements was 9 km. and for 80% settlements land requirement was rarely more than 600-700 acres i.e. within the radius of 1 km. from the land around the settlement. Thus between the two settlements minimum 8 km. of forest remained before the requirement for the agricultural land arises for other settlement. Most of the agricultural land came from the open land and not by clearing the forest. It was absolutely not necessary to go for the clearing of forest, it was not required even at the climax of urbanisation period[2]. And I do not think that any community would go for destroying the forests unless it is absolutely needed. This is very much attested in the traditional literature. *Arthasastra* refers to the protection of forests by the State. The reference of *Satapatha Brahamna* should be taken a little more carefully like any other literary evidence has been taken in Indian context.

CONCLUSION

We may now conclude the results of above analysis as follows :

1. That in the Ganga plains thick forest cover remained as late as 16th and 17th conturies A. D. and it would be erroneous to believe that large scale forest clearing was done in the middle of first millennium B.C.
2. That there was no fundamental change in iron tool typology and technology and their extensive

use as forest clearing tools from PGW to NBPW period[3].

3. That whatever the new types of iron tools were introduced in NBPW period were in the mid and late phase when the urbanisation was already an established fact.

4. That during the period of urbanisation and intensive colonisation fairly good number of settlements were on the river banks and lakes where open land was available and the average spacing was nearly 10 km.

5. That nearly 80% of the NBPW settlements were small villages having a population less than 500 people.

6. That the land requirement for the settlements indicate that rarely land was required beyond a radius of 1 km. and most of it was available without forest clearing.

7. That there was never any need for the large scale forest clearings in any period. Whatever little forest clearing was needed could be done with technology available to PGW people[3].

8. That the extensive use of iron plough share should not be over emphasized to till the hard calcareous soil as there was very little of it to till.

9. That the urbanisation of the Ganga plains was not due to the iron technology and the over exploitation of the extensive tilling of the agricultural land for the surplus[4] but mainly due to the culmination of several social, political and economic factors that were operating over many preceding centuries to channelize the energy, resources and generate a need and circulation of the surplus[5].

NOTES

1. While carrying out fieldwork in Bastar and Koraput districts this was my experience. Large settlements are located deeper into the forests and the agricultural land was available to them near the marshy patches and the lakes. They have rarely gone for the deforestation for the agricultural: land. Whatever deforestation has been done is by the wood contractors who are supplying the wood for construction purposes and fuel.

2. While some of the proponents of iron technology and surplus like to argue in the favour of extensive agriculture I may point out that the surplus is always available by the intensive agriculture and not by extensive agriculture/where the input cancels out the output (Boserup 1965; Tiwari 1969).

3. It may be worthwhile here to mention that the experiments carried out to visualize the forest clearings with Neolithic stone axes, as the case during the Neolithic period, turned out to be surprisingly efficient. It was seen that with the help of these axes which were obtained from National Museum, Copenhagen and not sharpened since the Neolithic age, two acres of jungle could be cleared within a few days and the stone axes were quite effective for the purpose (Iverson 1956). Also it must be remembered that Harappans reached the stage of urbanisation on a much greater scale without the help of iron.

4. To argue that technical feasibility was sufficient to start chain reaction which automatically lead to state formation and urbanisation would be too mechanical an interpretation of change (Thapar 1984 : 77).

5. I think it is important to understand that surplus is not an event but a process as it has been rightly argued by Adams (1965) and Chakrabarti (1973a, 1973b) to name just a few. The form of control is as important as the existence of surplus as is also the direction towards which it is channelled. It would be worthwhile to quote Romila Thapar. While discussing PGW culture she writes :

> "It would seem feasible that this material culture provided the base for the emergence of state with a monarchicl system of government in which the control of agricultural land and rights to succession would play a major role... It is clear that the potentiality for urbanisation came with PGW culture" (Thaper 1978 : 91).

Thus it is very clear that the potentiality of urbanisation was reached in PGW period but it could not be exploited simply because proper social, political and economic infrastructure was insufficient to mobilise and channelize the surplus.

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Archaeological Assemblages and Basalt Weathering : A Re-evaluation of the Nevasian

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Recent work (Mishra 1985) on the Quaternary deposits of the Nimar region of Madhya Pradesh, comprising part of the Narmada drainage, has shown that some gravels associated with Acheulian artifacts show significant weathering of basalt clasts. This observation has implications for the archaeological record. Since basalt is significantly weathered in the time span since the Acheulian, Acheulian basalt tools should also undergo weathering and one might expect the surviving Acheulian tool assemblage to be biased in favour of resistant rock types. In addition when resistant silica rock types are available as small nodules while weatherable rock types are available in unlimited size as is the case in the Deccan Trap region, the original assemblage might be biased for silica light duty tools and basalt heavy duty tools. In this paper it will be argued that the 'Nevasian' as defined by Sankalia (1960) is part of the light duty component of the Acheulian, isolated from the more weatherable heavy duty bifacial component by weathering and re-deposition.

The 'Nevasian' was first defined as a separate Paleolithic entity by Sankalia (1960) based on observations from localities around Nevasa on the Pravara river, a tributary of the Godavari (also see Sankalia 1956). At Nevasa, in a number of localities, flakes made on silica rich secondary minerals from the Deccan Trap were found to occur in one gravel lithounit (Gravel II). Another gravel lithounit (Gravel I) was associated with typical Acheulian bifaces primarily made on harder basalt types such as dyke rocks. The 'Nevasian' fit into a puzzling gap in the Paleolithic sequence as known then. Acheulian (Series I, Lower Palaeolithic, ESA) tools and 'microliths' had been found in most regions. The microliths were presumed, at that time, to date to a much later period. Now some of the 'microliths' have been shown to date to at least 25,000 B.P. (Sali 1980, Mishra 1985) and an Upper Palaeolithic phase is well established (Murty 1968, 1979, 1981). At the time when Sankalia was working at Nevasa no distinct stratigraphically separate horizon had yielded any equivalent to the 'Middle Palaeolithic' in India. The stratigraphic separateness of the Nevasian crude flake industry was therefore a welcome discovery and filled in the Palaeolithic sequence Sankalia was attempting to construct.

The Nevasian collections were studied in detail by Banerjee (1957). The points that emerged from this typological analysis were that the Nevasian was characterized by a very low incidence of prepared flakes, very few shaped tools, and very few types of retouch of the flake tools. Corvinus (1983 Fig. 97) in her collection of 'light duty' tools from Chirki-Nevasa found only 10/2639 light duty flakes were shaped by retouch. These characteristics of the Nevasian indicated it to be rather distinct from 'typical' Middle Palaeolithic industries as described from other parts of the world with a wealth of distinctive flake tools (eg. Bordes 1972, Wendorf and Schild 1974, Ronen ed 1982). More recently reported Middle Palaeolithic assemblages from India such as the 'Denticulate Mousterian' reported by Pant (1980) from southern U.P., the Middle Palaeolithic sites reported from the Rajasthan desert by Allchin et al (1976), the cave site of Bhimbetka (Misra 1985) and the Middle Palaeolithic of the Son valley (Sharma and Clark 1982) do have a much greater variety of specialized flake tools. In this context the comments of Roe (1982) on the differences between the flake tools of the earlier Acheulian and the transitional Lower Palaeolithic/Middle Palaeolithic industries is revealing. Roe characterized the 'Lower Palaeolithic' flake tools as having rare use of prepared cores, few standard shapes and little range of retouch and the Middle Palaeolithic or transitional Lower Palaeolithic/ Middle Paleolithic industries as showing the development of prepared cores and a wide range of retouch and specialization of flake tools. From this it can be seen that typologically the Nevasian assemblage resembles the Lower Paleolithic flake component. Infact the Nevasian stands almost isolated among the Middle Paleolithic assemblages anywhere in the world for the unstandardized and unrefined nature of the flake tools ! Typologically the Nevasian fits much better as the light duty component of the Acheulian than as a separate Middle Paleolithic flake culture. The question therefore is to what extent the context of the Nevasian supports it as a separate entity from the Acheulian.

The crucial data relevant to this question is provided by Corvinus' work at the site of Chirki-Nivasa (Corvinus 1983). Corvinus has excavated as many as 25 trenches in an extensive area from which Acheulian artifacts were being exposed by erosion of Quaternary sediments. Her trenches revealed an uneven bedrock surface upon which a 20-40 cm rubble deposit could be encountered in some of the trenches. The Acheulian tools were found abundantly within this rubble deposit. The rubble and bedrock were covered by a grey cross bedded occasionally very highly cemented alluvial gravel with a maximum thickness of 8 mt. forming a 13 mt. terrace at Chirki. The rubble layer yielded many 'heavy duty' (more than 8 cm.) Acheulian tools on basalt along with 'light duty' (less than 8 cm.) tools made on both silica and basalt rock types. The overlying alluvial gravel yielded occasional Acheulian heavy duty tools on both basalt and silica and an overwhelming proportion of light duty silica flakes (eg. Trench D : 9 heavy duty tools, 77 light duty tools on silica and 8 light duty tools on basalt, Corvinus 1983 : 24).

The occurrence of occasional 'Acheulian' tools in the gravel layer in association with Nevasian tools could easily be explained by the incorporation of older tools into a younger deposit. The occurrence of a light duty component identical in technique and typology to the Nevasian along with the Acheulian at Chirki however is much more difficult to explain if the 'Nevasian' is indeed a separate entity. Corvinus was therefore faced with the problem of whether the previously defined Nevasian which she was finding along with the Acheulian constituted a separate industry. While she avoids finally committing herself on this issue, Corvinus (1983 : 61) presents essentially the following arguments against the Nevasian forming a separate industry at Chirki. First of all many of the light duty silica flakes, indistinguishable from those found in the overlying gravel occurred within the same deposit as the Acheulian industry. Within the Acheulian levels light duty flakes occured, not only on silica rock types but also on basalt. Basalt cores for removing light duty flakes also occured showing that light duty flakes were deliberately manufactured in basalt and are not merely the debitage from heavy duty tool manufacture. Separating these light duty from the more diagnostic heavy duty handaxes and cleavers, chopper and polyhedrons makes nonsense of their associated context. Typologically there is no difference between the light duty tools of basalt (accepted as Acheulian) and those of silica (considered Nevasian). Both typology and context therefore as seen from Corvinus' cxcavations are highly suggestive of the Nevasian forming part and parcel of the Acheulian.

Only two arguments could be suggested by Corvinus for retaining the Nevasian as a separate entity. The first is that the Nevasian tools have 'filtered down' into the Acheulian rubble horizon (p 72). This is supported by the fact that the matrix of the rubble gravel is indeed similar to the overlying gravel and geologists working at the site (Rajaguru & Pappu 1970/71) could discern no major discomformity between the two units. This implies that both the rubble deposit and the overlying gravel were laid down during more or less similar period. However if this is so the question still remains as to whether the tools belong to two different time periods or one and whether they are older or contemporary with the deposits they now occur in ? The difference in the proportion of basalt to silica between the light duty component of the rubble (Acheulian) and alluvial (Nevasian) gravels and Chirki D at Nevasa has been pointed out by Corvinus (1983 : 72) with the implication that perhaps this difference shows a difference between the 'Acheulian' light duty and the Middle Paleolithic Nevasian. However since the only difference between the two flake components is in the proportion of raw material I think the explanation offered here is the more likely one.

As has been seen both context and typology indicate a strong association of the Nevasian with the Acheulian. The major evidence against accepting this, in my view is, if they are the same entity, why are there so few typical Acheulian tools such as handaxes and cleavers in the alluvial gravels. The crucial question is to explain the absence of these tools from the alluvial gravels.

Most of the Nevasian tools are made on cryptocrystalline silica minerals from the Deccan Trap. These are primarily cherts, jaspars, and chalcedony. All of these rock types are extremely resistant to alteration and would be able to undergo many cycles of transportation without being destroyed. Basalt however is primarily made up of ferromagnesian minerals and alkali feldspars which are among the most easily weatherable rock forming minerals (Pettijohn 1985 : 499). Infact the basalt tools from the Chirki rubble gravel are weathered. Corvinus reports a weathering rind of 2-4 mm thickness on most of the tools. Some of the tools broke while being extracted from their matrix (Corvinus 1983 : 76). A number of tools visibly deteriorated within a few years of being excavated (Rajguru and Pappu 1970/71). Since silica rock types do not usually occur in large enough nodules to prepare heavy duty tools, most heavy duty tools would be made on basalt. Differential weathering of basalt tools over silica tools in the original Acheulian assemblage containing both would result in the relative scarcity of heavy duty Acheulian over light duty Acheulian tools in the more thoroughly reworked deposits.

In this context it is significant that the heavy duty basalt tools occur most abundantly in the colluvial rubble horizon where transport of the material might have been minimal. The overlying alluvial deposit where cross bedding indicates stream transport contains resistant light duty silica component dispersed throughout the deposit. The few heavy duty tools which do occur are also on harder basalt, and even chert. The difference between the two deposits is not in typology but in lithology. I suggest that this discrimination is due to the differing intensity of disturbance of the original tool context and not due to man. The study of Baker and Penteado-Orellana (1977, 1978) on the river gravels of the Colorada river near Texas provides an interesting comparison with Chirki. Baker and Pentaedo-Orellana found that the gravels deposited during the Terminal Pleistocene were characterized by a higher proportion of resistant lithologies and abnormal relationships between lithology and rounding. Well rounded resistant lithologies occur along with sub-angular calcrete. If both rock types had been transported the same distance the resistant rock types should be less rounded than the softer rocks. The fact that the soft rocks are angular indicates a short distance of transport and Baker and Pentaedo-Orellana suggest that all the clasts are infact locally derived from older weathered alluvium. The Chirki gravels also show comparable features. Clay balls are reported from the cross bedded gravel indicating a short distance of transport. Other gravels in the Nevasa area yielding Acheulian tools, such as Hathi well and Baku Pimpalgaon are specifically mentioned in Corvinus' (1981) report as having an unusually high proportion of silica pebbles.

The hypothesis suggested here therefore is that the proportions of tools of different lithologies occuring in different contexts is due to the variable intensity of disturbance of the original assemblage with the more easily weathered rock types being selectively removed. The most vulnerable tools to destruction by weathering would be the basalt light duty flake tools due to their smaller size and thinness exposing more area to attack by weathering. The basalt heavy duty tools should be the next more vulnerable and the silica tools the least vulnerable. At Chirki tools were found in three different types of deposits and the proportion of heavy duty to light tools and silica to basalt tools varies dramatically in each of these contexts. This data is derived from Corvinus' (1983) excavations and can be summarized thus :

Deposit	*Trench*	*Heavy duty*	*Light duty*	*Basalt .*	*Silica*	*Ref.*
Rubble horizon	VII+VIII	71%	29%	56:44	(LD)	Fig. 81
Rubble horizon	IX	26%	74%	50:50	(LD)	Fig. 82
Rubble horizon	A+AA	96%	4%			Fig. 84
Alluvial gravel	All trenches			10:90	(LD)	Fig. 101
Alluvial gravel	All trenches	4%	96%			p 30-31
Chirki D	XII	33%	66%	95:5		Fig. 83

The three different deposits yielding tools at Chirki are the rubble deposit which is 20-40 cm thick resting on an uneven fluvially eroded bedrock, an alluvial gravel, and a deposit of weathered bedrock and colluvium at the border of the alluvial badlands and the rocky pediment. The assemblages from the rubble horizon are rich in heavy duty basalt tools. The proportion of heavy duty to light duty tools varies from 96% to 26% in the different trenches. The common point is that even in the trenches with the highest proportion of light duty tools this proportion is less than would be expected in any undisturbed site. The light duty component is approximately 50 : 50 silica and basalt even though the heavy duty to light duty component varies more. There seems to be a comparitive over-represention of the heavy duty element over the light duty element. This is supported by two observations made by Corvinus. First, the comparision of the waste present at Chirki with other primary Lower Paleolithic sites such as Latamne (Clark 1966) and Torralba and Ambrona (Howell 1966) shows that the percentage of waste flakes at Chirki is much lower than expected. The second is the comparision of the number of light duty flakes with the number of light duty cores. While there are as many as 11.6 flakes to 1 silica core there are only 1.3 basalt flakes to 1 basalt core (Corvinus 1983 : 72). If one considers the proportion of cores to flakes for silica rock types reflects the real proportions than basalt light duty flakes should be ten times more numeroue than they are. Additional light duty flakes derived from the heavy duty basalt tool manufacture should be present. The Acheulian rubble deposit therefore appears to have retained the basalt heavy duty and silica light duty components relatively intact, with a loss of a portion of the basalt light duty component.

The second type of deposit from which tools were recovered at Chirki is the alluvial gravel. The high proportion of angular pebbles and the size distribution leads to the interpertion of this gravel as a paleo-nala deposit with mostly short distance transported material (Rajaguru and Pappu 1970/71.) Tools occur throughout the deposit. Heavy duty tools are present but are comparatively rare and only occur in trenches where the rubble deposit is present (see p 30-31 of Corvinus 1983). All the tools occur are clear secondary context. The few heavy duty tools are clealy Acheulian. The light duty tools are also Acheulian. A few blade tools and cores on chalcedony occur and may be contemporary to the gravel deposition. The alluvial gravel has tools derived from some Acheulian horizon with basalt tools both of the heavy duty and light duty component severely depleted. If one considers the evidence of the fluvial erosion and freshness of the bedrock surface compared to the weathered condition of the tools and the continuity of the matrix between the rubble horizon and the overlying alluvial horizon one can interpert both deposits as considerable later than the Acheulian. The rubble horizon is one of minimal tool transport away from the zone of active stream transport while the overlying gravel is a clear channel deposit. It may be this difference rather than any chronological difference which accounts for the difference in the represention of the heavy duty element.

The most interesting tool context at Chirki however is that of the Chirki D area where trench XII was dug. This trench was excavated at the border of the rocky pediment with it's cover of black cotton soil and the alluvial badlands of the Chirki nala. The striking feature of this assemblage is that 95% of the light duty component is on basalt. The deposit within which the tools occur is essentially weathered bedrock and bedrock fragments probably detached by weathering. The high proportion of light duty basalt flakes, the most vunerable part of the assemblage indicates that very little material has been removed from this assemblage. If this is so then it implies that the original Acheulian context at Chirki is the surface of the rocky pediment valley. This context is similar to that reported from Hungsi (Paddayya 1982) where Acheulian tools and even bone occur just buried below the soil. A similar context is reported from Lalitpur (Singh 1965). Surface Acheulian sites are common whereever quartzite forms the bedrock. The importance of surface Acheulian sites and an understanding of their preservation therefore is emphasied by the results of the Chirki study.

To summarize, the argument presented here is as follows :

1. Typologically the Nevasian does not resemble a Middle Paleolithic industry but fits very well into the flake component of the Early Acheulian.
2. Infact, the light duty component of the Acheulian at Chirki is identical typologically to the Nevasian.
3. The rare occurrance of the heavy duty, typical Acheulian forms such as handaxes, cleavers, choppers and polyhedrons from the alluvial gravels which are rich in Nevasian tools, can be explained by the fact that most of the heavy duty tools were made on basalt since other rock types rarely occur in large enough nodules. Basalt weathers rapidly in comparison to other rock types. Therefore the basalt component of the Acheulian has not survived re-deposition into a much later secondary context.
4. The lithological composition of the tools asemblages at Chirki primarily reflects differing intensity of disturbance. In the rubble gravel small basalt flakes appear to be under represented. In the alluvial gravel only the silica component has survived. In the Chirki D locality the assemblage appears to be mostly intact.
5. The least disturbed locality at Chirki, based on the high rate of survival of the most easily weathered component, that is basalt flakes resembles in context Acheulian sites reported from other parts of India such as Hunsgi and Lalitpur.

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Archaeological and Environmental Researches in the Ghaggar (Saraswati) Plains :

Two Seasons of the Indo-French Archaeological Mission : 1983 and 1984

Preliminary Report (1983-1984)

H. P. Francfort

The Indo-French Archaeological Mission (M.A.F.I.) was set up in 1982 in collaboration with the Archaeological Survey of India and the Archaeological Research Unit n°10 of the Center for Archaeological Research of C.N.R.S. The objective of this mission is to allow Indian and French archaeologists to carry out joint research, both in the field and in the laboratory, for the mutual benefit of both parties. The expertise acquired by the Indian and French researchers will thus be put into practice in India and France in relation to particular historical problems, these being selected on a joint basis.

Selection of the problem to be researched was made in the course of discussions between the Indian archaeologists (D.P. Agrawal, K.N. Dikshit, J.P. Joshi, B.B. Lal, D. Mitra, B.K. Thapar) and the French team of researchers (H.-P. Francfort, J.-C. Gardin, P. Gentelle, B. Lyonnet). In the field, the team included the following people : R.S. Bisht (1983), K.P. Gupta (1983), A.K. Sharma (1984), J.R. Batra (1984), A.K. Sinha (1984), Puran Singh (1983/4), as well as M.-A. Courty (1983/4), H.-P. Francfort (1983/4), P. Gentelle (1983/4) and V. Roux (1984).

In the N.W. of India, for many years now, ever since explorations were carried out by Stein and Ghosh, we have been faced with the problem of the protohistoric populating and exploitation of the Ghagghar basin. The archaeological sites discovered in this region belong to different eras and have been associated with the former hydrographic network. This long-standing theory is well known and we will summarize it briefly : in the Harappan and pre-Harappan periods, the Ghaggar river flowed through the Ganganagar district in Rajasthan, down towards the Indus ; later on, the river became progressively smaller in the PGW period and eventually dried up. Following this, the river started to flow once again, thereby allowing renewed populating in the Kushan or Rang Mahal period. These periods during which a water course was or was not present were at times associated with climatic changes : a wet climatic regime in the protohistoric era, then drier and again wet during the first centuries A.D..

However, more recently study by Indian researchers of satellite photos has made it possible to put forward a more modern reconstruction of the history of this region which constitutes the environment of former cultures and civilisations. On the satellite photos the researchers located the paleo-channels of very wide rivers (6-8 km) which spring up at the foot of the Himalayas and run in a N.E.-S.W. direction. The present-day Ghaggar and Sarasvati rivers flow along part of these paleo-channels and one of the latter constitutes the water course called Chautang. These paleo-channels belong to much more important rivers than those which flow through the region today. The explanation put forward by the researchers who carried out this study is that the paleo-channels which belonged to an Indus/paleo-Ghaggar system were captured by the Ganges/Yamuna system. In line with this interpretation, these paleo-channels could only be those of the paleo-Yamuna, which would have curved towards the East following tectonic movements which occured in the piedmont regions of the Himalayas and in the Siwalik region.

D.P. Agrawal is prudently careful not to make hasty assertions and suggests that research be carried out in the field. Nevertheless, an interpretative historic hypothesis using current archaeological data has been put forward. Instead of resorting to an explanation based on considerable climatic changes, which in any case, have not been proven (no notable change in the climate since ca. 6000 B.C.), the history of the peopling of the region could be explained by the historical evolution of the paleo-channels of the Ghaggar system. Thus mighty rivers would have flowed from the N.E. in a S.W. direction, the river beds would have been 5 km wide and human settlement would have taken place on the banks in the protohistoric period (3rd millenium). At a certain time, tectonic upheaval would have caused a simultaneous shift of the water course and population towards the East, towards the present-day Yamuna. This shift would have occured either in the still badly defined Late Harappan period or in the PGW period or gradually during both since Late Harappan (Cemetery II) and PGW sites in the state of Bhawalpur in Pakistan are found on one of the paleochannels known locally as Hakra. However, the adoption of this hypothesis poses an interesting methodological problem. If we accept this hypothesis, we *must* logically accept as well that another tectonic upheaval would have made the rivers revert to the Kushan (Rang Mahal) period since sites from the latter are again found in the region. If not, if another explanation for the Rang Mahal populating is put forward, there is no logical reason why yet another should not be accepted at least as a hypothesis which can be tested for the protohistoric period. Therefore, the question which arises is the following : what is the exact relationship between the hydrographic system (former and present) and the archaeological remains of the Ghaggar system ?

Whilst the Indian researchers were tackling this important problem, French archaeologists working in Central Asia (N.E. Afghanistan) were discovering two types of data which had significant implications for a region such as N.W. India.

First of all, systematic archaeological survey enabled the discovery of not only hundred of sites, the collection of tonnes of potsherds but as well the survey enabled ground traces of vast networks of artificial irrigation to be located, the latter belonging to the following periods : Medieval, Heptalite, Kushan, Greco-Bactrian, Achaemenian, Iron Age, Bronze Age. The irrigation networks from the Bronze Age rank among the oldest found in Central Asia and some canals measure up to 20 km in length. Moreover, archaeological sites have been discovered, which are associated with the irrigation networks. Thanks to the ceramic sherds which have been collected, these sites enable dating of the irrigation networks. Among the sites discovered, one revealed material similar to that from Baluchistan cultures of the Chalcolithic period. Another site from the Bronze Age, Shortughai, confined to an area in the vicinity of Amu Darya, has been shown to be completely Harappan, of the mature period. In the presence of such discoveries, the question arose as to whether the technique of artificial irrigation used by the "Harappan settlers" of Shortughai could not have in fact been brought by them from the plains of the Indus basin. In view of this, it was necessary to consider the possibility that the artificial irrigation originated in N.W. India. The problem was therefore clearly stated : did artificial irrigation networks develop in N.W. India in the protohistoric period ?

In fact, if no notable change has occured in the climatic conditions for ca. 8000 years, it is necessary to admit that the growing of winter cereal crops (wheat, barley) in a semi-arid area requires a supply of water, this being possible only through irrigation. The winter cereals make up the basic means of subsistence of the protohistoric populations in the region. Therefore, the original plan was conceived so that it would have to verify if the gigantic rivers which were supposed to have flowed in the paleo-channels N.E.—S.W. belonging to the former Ghaggar system would have been used (or not) by the protohistoric inhabitants of the region to create irrigation networks. The selection of an area for field study aimed at answering this question was the result of a joint decision taken by the Indian and French team members. It was decided that a restricted part of the Ghaggar paleo-system would be studied so as to find an answer to the question which had arisen. The first field operations focused on the Delhi, Hissar, Jhunjhunu region, the second on the triangle made up by Hissar, Darba and Bhadra.

What method was used to approach the problem ? Taking into account the experience acquired by the researchers of both countries, a particular type of strategy was devised so as to accord particular importance to geo-archaeological aspects. In fact, in order to be able to search for remains of irrigation canals, to examine the traces left by river paleo-channels and situate sites on the hydrographic networks, it is necessary to gain an understanding of the evolution of the area through in-depth study in the field. This is why the team was made up of a geographer, a geoarchaeologist and archaeologists, the latter including an ethno-archaeologist for reasons which will become clear at a later stage.

The geographer—a specialist in former irrigation system—has worked in various regions within arid zones (Greece, Syria, Jordan, Yemen, Iran, Afghanistan) and has a good knowledge of geomorphological problems. He has to understand relief and landscape formation dating back to the end of the last glaciation. Interpretation of the line indicating former water courses, study of river terraces (when these occur) are also the geographer's responsibility. Establishing the course of the former canals and detailed localization of sites require meticulous observations which as well are part of the geographer's work. The geo-archaeologist handles research at the microscopic level. She must have a sound knowledge of geology, of pedology and be familiar with the evolutionary process of soils in semi-arid areas, including both natural soils and those which have been subjected to human activity outside the sites (agriculture) and within the sites (archaeological layers). She proceeds in two stages: first of all comes the task of reconstituting paleo-relief pattern of a region as it would have been at the time the rivers flowed, next the detailed history of the quaternary formations up to the present. The implementation of sophisticated methods of observation and dating are necessary. It is essential in particular to relate the archaeological sites to the surrounding paleo-soils in order to be able to conduct research for example, into evidence of irrigation, of the use of manure, or into salinity problems. The techniques of analysis brought into play range from chemical analysis and granulometry to micro-morphological examination of "mammouth" thin sections.

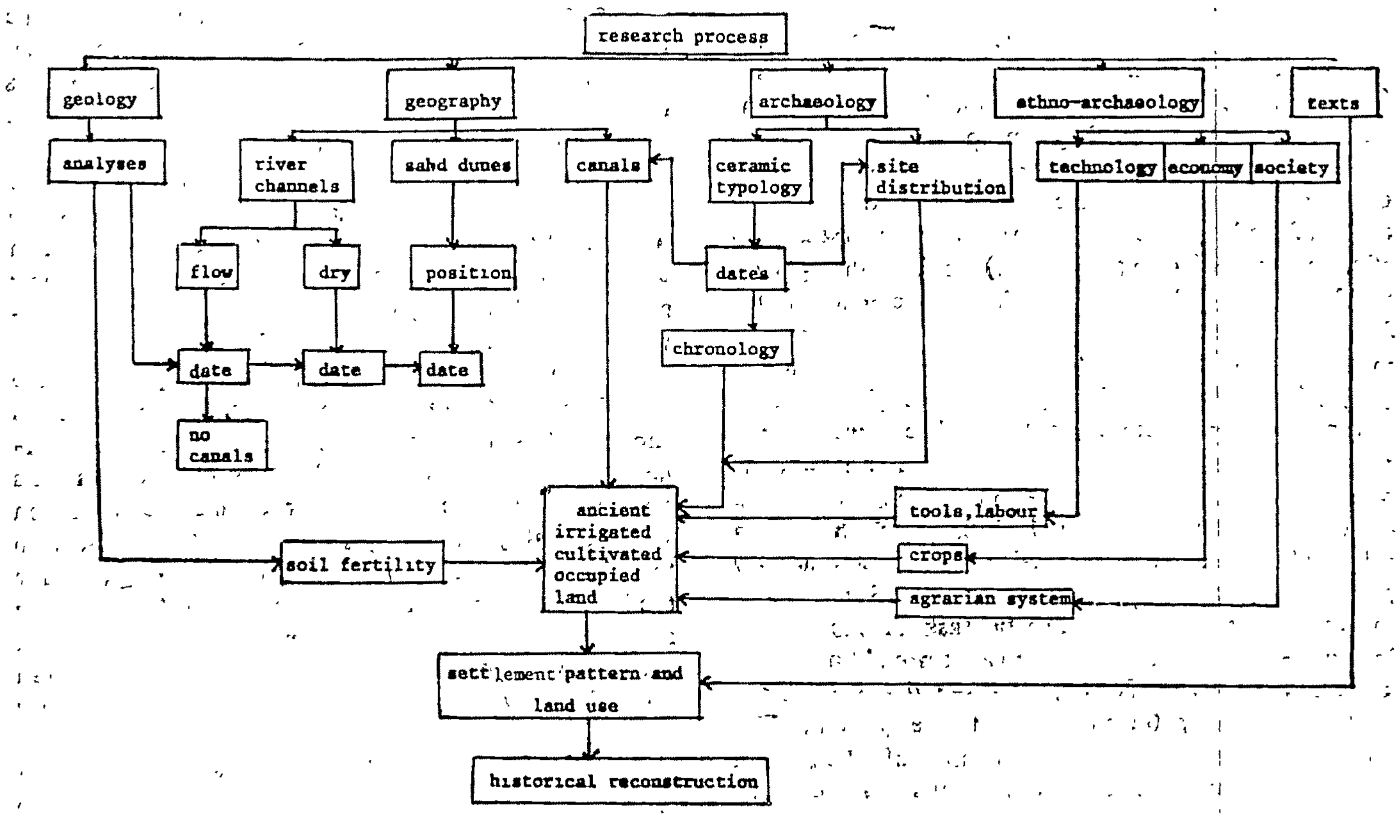
The archaeologists take care of the sites which they locate, describe and on which they collect a very large amount of pottery; experience has shown that one cannot, in fact, limit oneself to just picking up one or two broken pieces of pottery and consider these as diagnoses. It is necessary to carefully examine tonnes of such potsherds so that the trace of a former period covered up by material of more recent periods may, on occasions, be detected. Moreover, detailed typologies are required, these being established using modern means of taxonomy. Computarization of data concerning the sites and the potsherds is envisaged to enable large quantitites of data to be easily handled.

The ethno-archaeologist deals with a whole set of problems relating to the reconstruction of economic systems and past societies, by combining archaeological data and information about modern traditional societies obtained from archaeological surveys. This does not just amount to observing, in present day villages, those forms or structures which more or less resemble those obtained through archaeological investigation; it is also necessary to make quite explicit the approach which enables, or which does not enable, models of how economic and social systems functioned to be put forward based on material data. The surveys done by ethno-archaeologists are tied up, for example, with the way villages water and use a plot of land, the way tools can indicate something about the way the soil was farmed, the groups of specialized craftsmen etc....In this case the data will be used either at the reconstruction stage or final synthesis stage, for different periods, with the aid of textual data, whenever these exist, as for the Middle Ages. Drawing on the knowledge already acquired through prospecting and excavation work carried out by Indian researchers, who have worked in the region, obviously constitutes an essential preliminary stage of the work. Moreover, in the near future, it will be essential to complete the surface survey with data found buried beneath the surface so as to clear up problems arising either from ecofacts or from artifacts. It will be necessary, for example, to amass additional stratigraphic information about the pottery from certain periods which up until now have received little attention. It will also be necessary to check for the presence of canals and to date these using potsherds found at the bottom of canals, and by digging trenches. It will be necessary to study the organic remains (grains, carbonized wood, bones) so as to complete the picture of the reconstruction of farming activity and of the environment of different periods.

In order to do that, trial trenches or excavation works will one day be required.

The following diagram sets out the research process implemented by the M.A.F.I. It is quite clear how the team proposes to resolve the problems which have been formulated. An estimate of the surface area of the occupied, farmed or irrigated land is shown in the center of the diagram. This estimate is the pivotal piece of the reasoning process. Results of the first two field work operations which took place in 1983 and 1984 are given on the following pages. Although the results are preliminary ones, we can already be quite certain of particular points. This being a preliminary report, the bibliographic references have been reduced to include a basic minimum so as to set out the data for scientific discussion. The unabridged study will be incorporated into the final publication along with all necessary references.

INDO-FRENCH ARCHAEOLOGICAL EXPEDITION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ancient irrigated cultivated occupied land
tools, labour
crops
agrarian system
soil fertility
settlement pattern and land use
historical reconstruction

Archaeological and Environmental Researches in the Ghaggar (Saraswati) Plains :

Two Seasons of the Indo-French Archaeological Mission : 1983 and 1984

Landscapes, Environment and Irrigation : Hypotheses for the Study of the 3rd and 2nd Millenniums

P. Gentelle

The region studied in 1984 by the M.A.F.I. makes up a triangle with sides measuring about 40 km between Siswal, Bhadra and Darba and extending over both sides of the border separating the States of Haryana and Rajasthan. The region is situated entirely within the 'arid' part of N.W. India, right at its northernmost limit.

The topography is characterised by fossilized dune masses, with relative altitude of up to 15 m, alternating with depressions in which alluvial deposits of the great Indo-Ganges piedmont plain are found. These alluvial deposits are mixed at the surface with sands blown in by the wind during the Holocene period during the dry, hot summer season and are in part taken away by run-off occurring at the time of the July-September monsoon.

The climate is sub-tropical (latitude 29-30°), continental (the Ocean is 1600 km away), semi-arid (300 mm rainfall, very uneven distribution) and subject to the monsoon.

The hydrography of the region is almost non-existent. It is worthwhile noting in this respect that no flow of water leaves behind a distinct trace on the ground surface. Exceptional storm water is needed before major run-offs leave behind a trace on the ground ; on the other hand, all depressions, even those hardly visible to the naked eye, collect water.

In the sub-soil, the subterranean sheets of water are deep, between 25 and 50 metres, except in the depressions where they occur near the surface. It is therefore essential to rely on wells, If modern equipment had not been available for the last thirty years or so in Haryana and in N.W. Rajasthan for the last twenty years, nine-tenths of the crops would be dependent on the rains. Today, the landscape is completely modified by the fact that the canals from the Yamuna and the motorized well enable a rate of cropping of up to 80% to be achieved in the best districts in the Haryana region.

The vegetation reflects the general desert conditions. Crops grown in dry soil, which most often feature in studies of farming without irrigation, are for rabi crops, *Vigna radiata* (Gram) in those areas receiving less than 200 mm rainfall and *Cicer arietinum* in places receiving more than 200 mm rainfall. For Kharif crops, pearled millet (Bajra) as well as a fodder plant, *Cyanopsis tetragonoloba* (Goar) are found throughout the region. One tree is cultivated, *Zizyphus mauritiana* (Ber).

Those inhabitants in the region who do not succeed in connecting their land to irrigation networks and who thereby depend solely upon the rains and the wells are particularly careful with their herds (goats, sheep, hump bull and buffalo, dromadery). They rely on the animals so as to avoid suffering the worst consequences of a year-long drought ; wandering cattle however, have a harmful effect on the upkeep of the region especially in the driest parts.

The region in which the M.A.F.I. carried out surveys shows no organised hydrographic network. This absence of present-day flows from rivers and the concomitant existence of proto-historic sites obviously posed a problem. This anomaly has in fact been perceived by a number of authors for some time now ; it has been the subject of several studies none of which, at the present time, completely account for the situation. Among the problems which have attracted the attention of researchers over recent years is that concerned with paleo-flows and correlatively, the problem of paleo-climatic variations. One of the objectives of the survey was to incorporate, where possible, new elements within publications which have all contributed in an important way to the discussion.

Across a vast stretch of land between the Yamuna to the east and the Sutlej to the west, between the piedmont of the Siwalik to the north and the edge of the Aravalli to the south, no river today seems to be able to explain the existence of dozens of archeological sites belonging to several periods, whereas their size in fact implies the existence of important economic resources. Moreover, irrigation, today as in the 19th century, as well as during the Moghul period is a sine qua non of intensive farming. Without supply of artificial water, the villages just subsist on the poverty line, pastoral economy barely making up for the deficiencies of subsistence farming periodically threatened by drought.

1. Results for 1983

The M.A.F.I. thus undertook the examination of the natural conditions which enabled civilisations revealed by the archaeological sites to develop. The first survey mission, in 1983, was a mission of general reconnaissance based on some mapping documents : maps with scale 1/50 000° and on preceding surveys. Some of the time was devoted to the southern zone of the region. The task here was essentially to understand the conditions affecting the flow of rivers coming from the Aravalli, to observe the relationships between the present-day and former river beds and the dune masses and to study the possibility of the existence of flows once more important that they are today and which could explain the distribution of the sites. Thus the regions covered were the lower channel of the Dohan, also of the Kantly, the dune systems from Churu to Narnaul.

The results obtained can be summarized as follows :

A—The dunes in the region correspond to three superimposed dune masses ; the oldest, transformed by clear rubifaction, is rarely exposed. It appears only on the glacis which surround the rocky outcrops scattered here and there across the landscape and lined up along the former anticlinal axes of the Aravallis. This mass I is covered with a mass of sands and yellow silt II formed with the return of windy conditions at a time which could date back to the Holocene period and with very fine alluvial deposits.

(B) The Kantli, which brings water to the southern part of the region in summer, stopped flowing north at the surface beyond Rajgarh well before the dune mass II became established. The river left very clear traces behind by re-shaping the dunes which generally run from west to east in the region situated south-east of Jhunjhunu. The dunes as a result, now run from south to north. Further north still, the traces of the river's flow end with inter-dune spreads these having no dug-out channel, and with small depressions, the age of which could be determined by analysis of the deposits.

(C) The Dohan follows the same pattern as the Kantli.

(D) Observation of the lower channel of the Kantli and of the Dohan leads us to think that the present-day river swellings, like those in the recent past, hardly exceeded the limits put forward here (Rajgarh for the Kantli, north of Mahendragarh for the Dohan). If it were possible to detect with some degree of certainty some paleo-channels leading further north (particularly by means of aerial photograph study) we would most likely find remains of paleo-flows dating back to the Quaternary or at least to the pre-Holocene period. Therefore it does not appear that we can correlate the possible existence of these paleo-channels with the presence of Harappan or pre-Harappan sites.

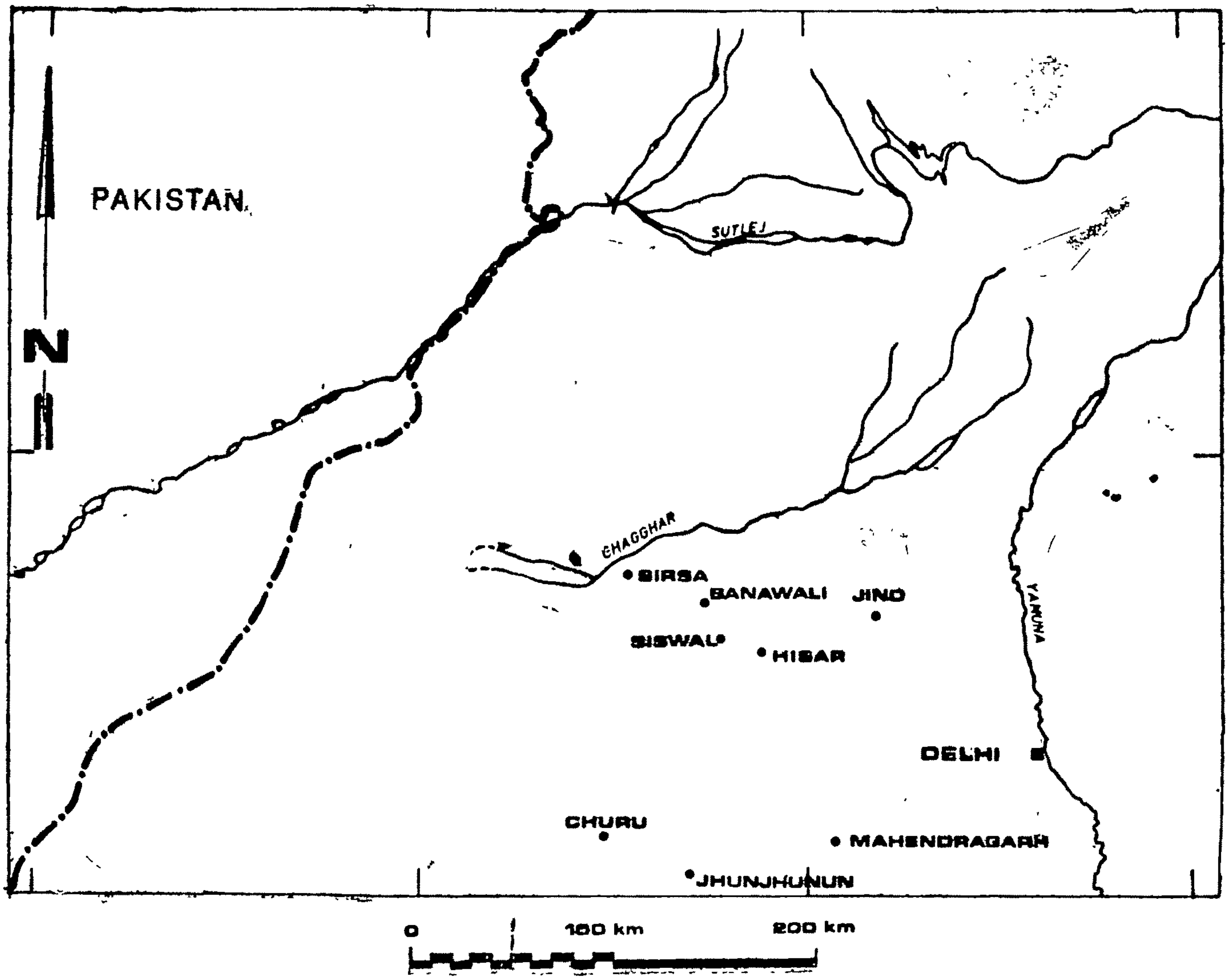
(E) The first days spent surveying the region in 1983 were devoted to the area between Rohtak and

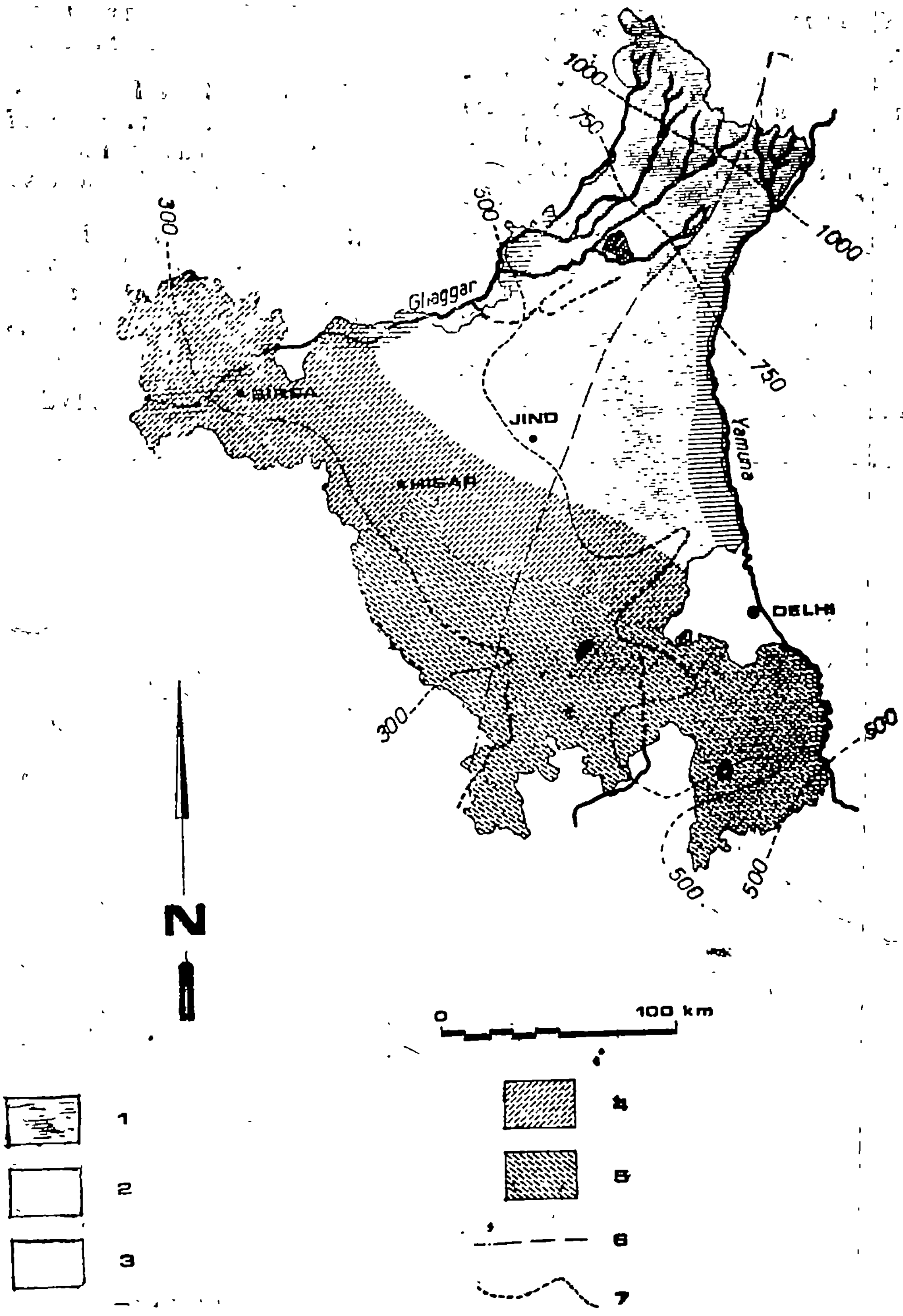
Hissar. While human occupancy there dates back to antiquity, it is relatively difficult to study today because of the recent success of the "green revolution" : farming is omnipresent, very dense human occupancy (one village on average every 4.5 km) linked closely to modern irrigation has meant that most of the previous states of soil occupancy have disappeared. Since the region is extremely flat, the fields levelled out, the flow of water slow, regular and hard to detect with the naked eye, it does not seem desirable to make the region the subject of a preliminary study. On the other hand, the area must be included in an overall geomorphological study if the way the river flows functioned and irrigation developed in early times, especially around Jind and Rahi Gari, are to be properly understood.

(F) Heading west from Hissar, up to Bhadra, the region is indeed promising ; it seems in fact that one simply must be able to find remains of exploitation dating back to the Middle Ages at least.

Since the Harappan site of Siswal is found exactly along the path of the Firuz Shah canal, not far from the former Chautang river bed, further survey towards Bhadra is of top priority, this being the case for work carried out in 1984.

(G) The Ghaggar river region to the north was not sur-




1000
750
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Ghaggar
SIRSA
HISAR
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1. Flood plain 2. Possible floods
3. Drough

4. Dunes 5. Dunes and rocky outcrops
6. Watershed 7. Rainfalls

veyed in 1983. A brief trip to the area only enabled us to realize that its present course could in no way be directly related to the paleo-rivers which crossed the region during the Quaternary period the entire lower section of the Ghaggar river bed, up to and beyond Kalibangan, will have to be the subject of careful geomorphological study, which will complete prior studies undertaken over the last several years by Indian archaeologists, geologists and geographers.

2. Results for 1984

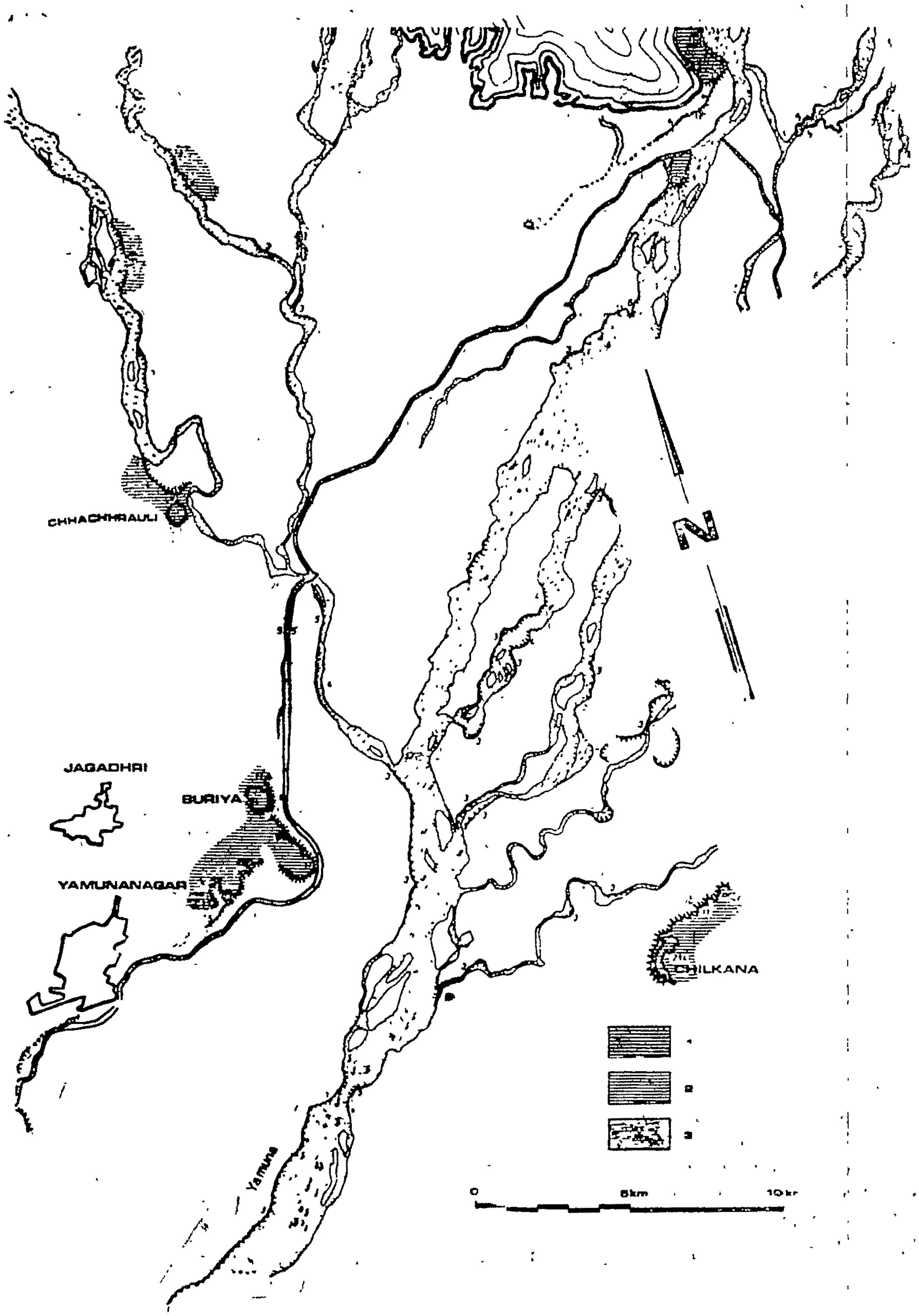
Surveying during 1984 brought forth new results but no final conclusion can yet be drawn from field observation ; further studies devoted to particular points already surveyed are required, while other points still have to be obtained from future surveys. The results for 1984 can be summarized as follows :

(A) The question of change in direction of the Yamuna, which could have flowed towards the Indus in Harappan times and which would later have been diverted towards the Ganges river system is worthy of an in-depth geomorphological study.

Where the Yamuna opens out onto the plain near Faizpur, the river cuts through a system of fluviatile terraces ; the lowest is found 2-3 metres above the main river bed and can be partly flooded when the river swells during the monsoon ; a second terrace is clearly visible about 5 metres above the present river bed ; a bit of a third terrace is visible at 25 metres covered with big boulders. It is hard to accept that the Yamuna river bed abruptly changed course only 5000 years ago, especially when one remembers that the terraces are established and that the small tributary, the Somb Nadi, also cuts through a terrace. Further south, near the village of Buriya, north of Yamunanagar, the remains of a terrace rise up to a height of 11 metres above the present-day valley. Moreover, traces of this terrace which stands 280 metres high and which is encountered once more at the same altitude on the other bank of the Yamuna at Sultanpur, are clearly visible to the north and south, the limit between the flood plain and terrace can be clearly made out going towards Karnal, Panipat and Sonepat. Moreover, the line dividing waters from the Ganges from those belonging to the Indus system runs well wide of the actual Yamuna channel; this limit running approximately along an axis situated directly east of Thanesar, Jind and Bhiwani. Finally, the trace of a river bed corresponding to the strength of the Yamuna and even more, to a flow dating back 5000 years, is not found anywhere in the piedmont between Jind and Sirsa. It is indeed necessary to ascribe the existence of traces of paleo-flows in the region to much earlier periods. In historic and protohistoric times during the whole Holocene period and probably before, the Yamuna flowed towards the Ganges.

(B) If the Yamuna did not flow west during the Harappan period, the Pleistocene paleo-flows such as the Chautang depression or the depression which today makes up part of the Ghaggar, were hardly more active 5000 years ago than they are today. Thus it is necessary to look for other possible cause to explain regular and abundant supply of water to the series of archeological sites found on the plain. For the Chautang region at least, the only possible explanation is that extensive irrigation once existed in the area. This is why surveying in 1984 concentrated on looking for traces of canals in the zone which seemed the most favorable for the conservation of traces still visible today, the Hissar-Darba Kalan-Bhadra triangle.

(C) Along a stretch of about 50 km between Hissar and Bhadra, it is possible to follow ground traces of a canal dug in the 14th century and subsequently taken over in the 17th century by the Moghuls. This canal took water from the Yamuna, thereby inaugurating in modern times an irrigation model based on flow of water towards the S.W. from the right bank of the Yamuna. The vicissitudes which beset this canal are known. The remains of it, from Hissar to Siswal, passing through Matarscham and the surrounding area, constitutes a sort of long roll of sand, on average about 50 metres wide, 2 to 3 metres high. In recent times (19th and 20th centuries) it was dug out in places. Along a section of the canal it is very easy to follow the traces of these successive diggings, edged occasionally with lines of trees. It is to be noted that the Harappan site of Siswal is found right on the path of the canal,


CHHACHHRAULI
JAGADHRI
BURIYA
YAMUNANAGAR
CHILKANA
Yamuna
N
1
2
3
0
5km
10 km

its "tell" being quite distinctive owing to surrounding crops and 4 metre elevation above the plain. Beyond Siswal, the former canal continued further west ; today only a long sandy strip remains. It is out of reach for watered crops, three to four metres high and about fifty metres wide. Several branches have been recognized as stemming from this common trunk, these branches being identifiable owing to the mass of sand which distinguishes them from the rest of the fields. These sand masses, remaining after evacuation of mud from year to year at canal clearing time are valuable indications of the presence of canals in an irrigated landscape. All farming peasants in the region know of the existence of this former canal and how long it was. This is why they also know that west of Siswal, the canal which goes towards Darba leaves the CHauthang depression. The latter can be seen on the main due to the density of the wells which stretch along it and which today, are connected to an irrigation system using the underground water concentrations in the channel of this paleo-flow.

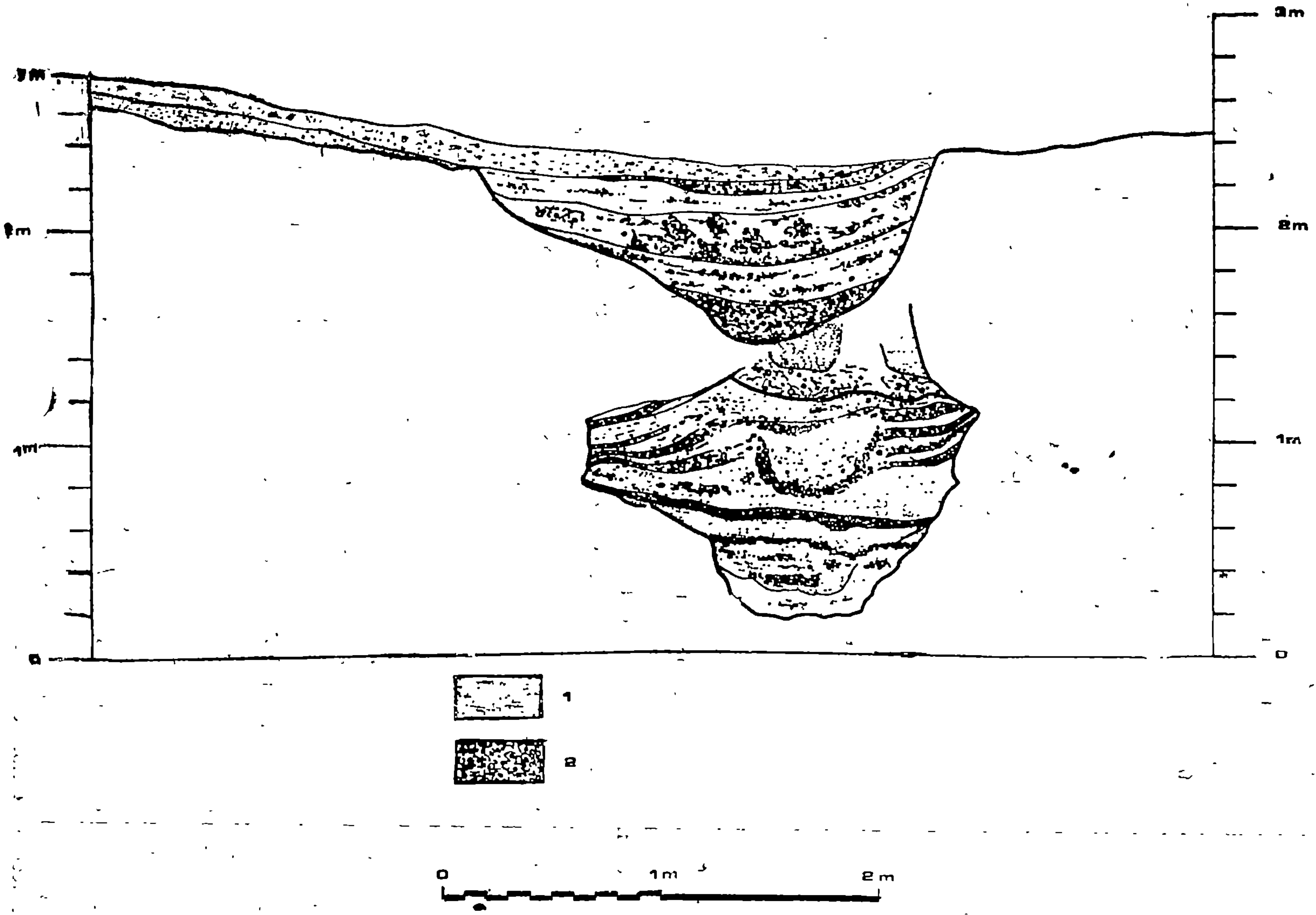
West of Siswal, a branch of the canal coming from Hissar heads towards Bhadra ; its path is less easy to make out than that of the Darba branch. Moreover, it is made complicated by the fact that a canal going towards Bhadra was dug at the beginning of this century ; here and there it cuts across former remains. As well, detection is complicated because successive exploitation of the region has left traces which today are broken up due to advances in modern farming. Between Siswal and 3 km east of Bhadra, the remains sighted are indicated on the 1/50000 scale map where they appeared in the form of long sand mounds shown by the cartographer.

(D) 3 km east of Bhadra, the digging to a depth of 3 metres in the bottom of the depression by the town brickworks has revealed a water flow channel in the rock face running between two mounds of rubble. This is why it was decided to make a deeper section so as to establish if there were at one time canals underneath the visible one. Thus it was possible to uncover, 3.20 metres below the actual ground surface, the bottom of a canal clearly laid out between two distinct sand masses.

The sand mass on either side of the channel is entirely marked out by traces of rust deposits in the many small cracks into which water percolated over a long period. The canal itself is filled with fine layers of almost pure sands about 2-3 cm thick which alternate with thin film of flaky clay. These very fine beds are covered with a deposit which is quite thick, measuring several dozen centimetres at the center, this being a feature of beds formed during the abandon phase of a canal. They are made up of a non-sorted mixture of sands and various soils showing no signs of flow. This deposit, which marks the end of the canal's lifetime, is covered with a more or less uniform 'pink' layer, which forms a sort of thick filling-up of the canal depression. From there on, going up to the top of the section, the depression is filled up with more or less brown layers, the entire filling being more than one metre thick. This latest state of channel flow revealed some potsherds.

Further digging enabled the discovery of two other canals placed one on top of the other. The dimensions of these suggest the existence of a small irrigation canal rather than of a river (refer to diagram). For more than one metre thickness and more than 1.5 metre width, which once later ground compression and transformation are taken into account means dimensions should be no more than double, the section shows two main states and provides a record of sandy deposit developments in a zone where running water creates series of bine bed sediment. Some potsherds were found in the canals as well as in the sand mass, including the bottom of the sand mass. Dating specimens obtained in the deepest layers has furnished worthwhile results even though the way the potsherds were submitted for analysis (following washing and drying) makes results imprecise.

The fact that we find at a depth of more than 4 metres traces of water flow canalised in a pipe which is quite small and which is perhaps three thousand years old, quashes the idea which could be developed about the existence of a big natural flow, except if we suppose that the four metres and some deposits seen in cross-section constitute only the most recent and, in all, very limited part of previous vast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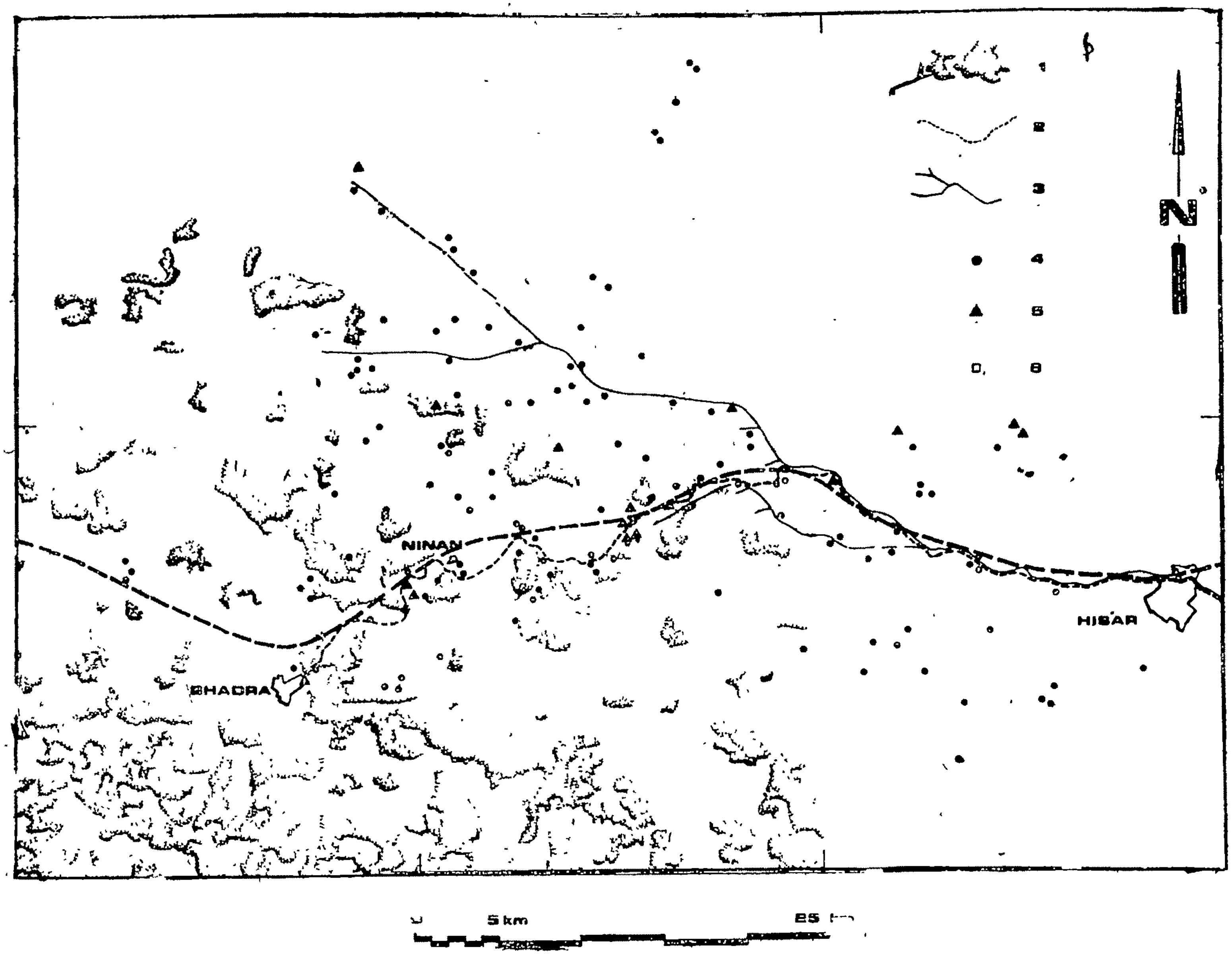
1m
2m


N
1
2
3
4
5
6
HISAR
NINAN
BHADRA
5 km
25

alluvium depositing which would have stopped abruptly and leaving in this area just a slight flow of rain water. Whichever way we interpret the section it adds at the very least elements which deserve that we look elsewhere for other elements which will confirm or invalidate the interpretations put forward.

CONCLUSION

At the present stage of research carried out in the region by the M.A.F.I. it appears that previous studies, a list of which is given in the bibliography, have perhaps underestimated the possibility of a major development of massive irrigation systems across the Indo-Ganges piedmont in the Harappan period, perhaps before and certainly after. Research devoted to purely geomorphological traces, combined with a detailed study of all elements encompassed by the landscape, should provide a final solution to the long researched question of paleoflows, the traces of which are today visible on the plain. The discovery of previous flow channels must be discussed in detail. This aspect has not been dealt with in this report since it requires a considerable number of pages and checking in the field still has to be carried out. In a future publication, all hypotheses put forward by the various Indian and foreign researchers will be looked at in the light of additional elements obtained from surveys done by the M.A.F.I.

The hypothesis that we put forward about the existence of large irrigation canals which could date back to the Harappan period, must also be proven out in the field ; it is for this reason that research devoted to such remains must be done in an active way. We shall take good care not to forget that the use in Bactria of long canals measuring about twenty kilometres and constructed thanks to the remarkable knowledge of hydraulic techniques, as has been demonstrated in the Ai Khanoum plain and at Shortughai, has been ascribed to a small social unit having close ties with the Indus valley civilisations. The question about the origin of these irrigation techniques has not yet been answered. We will also be careful not to forget that irrigation techniques hardly evolved between the 3rd millennium B.C. and the first millennium A.D. ; construction during the 14th century of large canals coming from the Yamuna and extending at least up to Bhadra, this having been already proven, shows that the possibilities for creating such irrigation systems have existed for a long time and could not have been beyond the capabilities and level of technical achievement acquired by Harappan civilisation. Therefore it is important to carry studies needed to confirm or invalid ate our hypotheses through to completion and then to submit results for critical assessment.

Geoarchaeological Approach of Holocene Paleoenvironments in the Ghaggar Plain

M. A. Courty

Dunes and sediments associated with archaeological materials from the Indus basin and the Rajasthan desert have not been deeply investigated from a geological and pedological point of view. Previous reconstruction of Holocene paleo-environments in this area are mainly based on paleobotanical analyses completed by the observation of satellite photographs and by archaeological data. However, sedimentological techniques can be applied successfully to the study of ancient landscapes in relation with archaeology.

In line with the archaeological surveys, field reconnaissance of the fossil hydrographic network and of the soil cover were undertaken during the 1983 and 1984 field surveys in order to establish the relations between the modifications of the human settlement pattern and the evolution of the environmental conditions since the Harappan period up to the present time.

Conclusions were mainly reached on two points :

—reconstruction of stratigraphic sequences in which alluvial deposits of various kind alternate with sediments reworked by wind,

—characterization of soil properties developed over the last five thousand years : these properties appear as deeply influenced by the processes of sedimentation (flood and wind effects). These changes could have affected the dynamics of human settlement during the same period.

Sediments and soils were studied in the field in more than 100 profiles located on the various geomorphological units : dune area, ancient flood plains, levees, active flood plain, ancient depressions and present-day river beds. Deep sections (15 m observed, information collected on more than 40 m) were studied taking the opportunity of the abundance of non-brick covered wells in this region. Research work was carried out at the same time on surface soils and on buried soils below archaeological sites dated from the Protohistoric period up to the Historic time (Siswal, Mitathal, Kalibangan, Banawali, Bhadra, Agroha). Occupation layers also were studied in these tells as they can provide information on the type of sediments and plants used in the past and are thus remnants of ancient landscapes. Sediments from remains of ancient canals were analysed as the evolution of materials transported by canals is closely related with the modifications of landscape with time.

350 thin sections were made from undisturbed samples and studied under the petrographic microscope. Mineralogical composition, particle size distribution and relative distribution of the various components investigated simultaneously in thin section can provide basic informations on the nature, origin, way of deposition and of alteration of sediments and soils. From these characteristics it is thus possible to distinguish aeolian sediments slightly reworked by water and alluvium slightly reworked by wind for materials of the same origin. Such informations cannot be obtained so easily through analysis of disturbed samples as the particle size one.

Complementary data were also obtained from the study of samples through a scanning electron microscope and by chemical and physical analyses.

The mineralogical composition of the sediments deposited during the late Holocene varies in a very small extent as they are mostly originated from the Siwalik Hill ranges. The significant variations were more the particle size distribution and the amount of the most representative types of minerals, e.g. quartz sand grains, mica flakes and calcium carbonate detrital particles.

Two main types of alluvial materials were distinguished. The first type appeared in the field as grey sands. They are very rich in large fresh mica flakes (200 μm), in well-sorted coarse silt quartz grains and do not contain calcium carbonate grains. These sediments have very close characteristics from the present-day alluvium of the Yamuna river and as these last ones are clearly originated from inside the Himalaya and were transported by powerful rivers. They were recognized in deep sections at more than 7 m where they seem to be part of a large alluvial plain in which no preferential channels were observed.

On the other hand, the micaceous sediments found in the upper section and below archaeological sites were yellowish grey, rich in partly weathered mica flakes, in fine silt quartz grains, in calcium detrital particles and with various amount of weatherable grains derived from metamorphic rocks. Along the ancient depressions, as the so called Sarasvati and Chautang ones, these micaceous loam were interlayered with clayey loam rich in very fine mica calcareous silt and partly mixed with sand grains. Besides the depressions they alternated with well sorted, sub-rounded fine sands made up mostly of quartz and weatherable minerals combined with some very rounded mica grains and of detrital calcium carbonate grains.

All the deposits appear as alluvial in origin and very similar to the present-day alluvium of the Ghaggar river originated from the Siwaliks. Compared to the grey sands, the fine granulometry suggests that sedimentation was carried out by slow flowing waters, whereas the fine layers represented a resorting of fine alluvium when the load capacity of rivers was very low and in consequence only preferential channels were active. The sandy population was the result of local aeolian reworking of the alluvial flood plain.

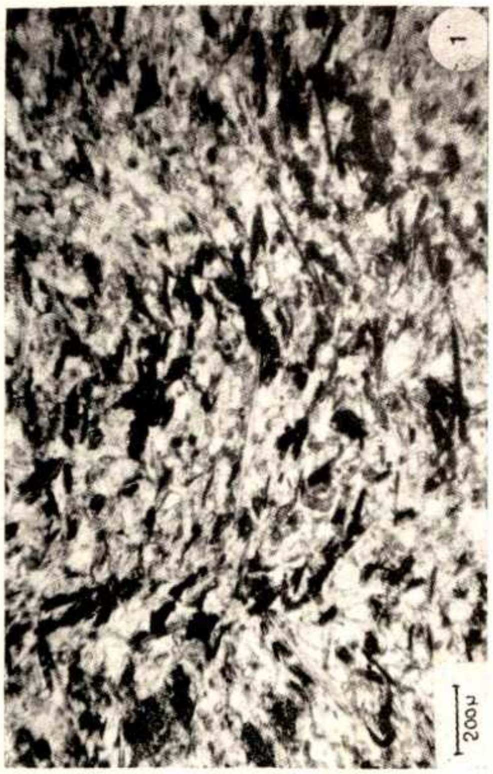
The interlayering of these three types of sediments throughout all the Ghaggar basin indicates that the alluvial plain was seasonally flooded and at the same time intensively reworked by wind. These combined sedimentological processes lead to the gradual infilling of channels.

Not any alluvial deposit was observed in the upper 4 m. In the ancient depressions signs of slight water effects were recorded as the high amount of fine fraction. But these sediments were clearly the product of local resorting of previously deposited alluvium by seasonal floods as no more fresh materials was deposited. Most part of the sub-surface sediments were brownish yellow, mediumly sorted sandy loam to loamy sands with some rounded biotite and detrital calcium carbonate grains. These characteristics besides the high amount of weatherable minerals and the rather high content in fine fraction indicate that these sediments are originated from the ancient flood plain and have been locally reworked by wind. This reworking was not intense as proved by the weakly rounded shape of quartz sand grains and the weak degree of dissolulion of fragile minerals as observed under the S.E.M.

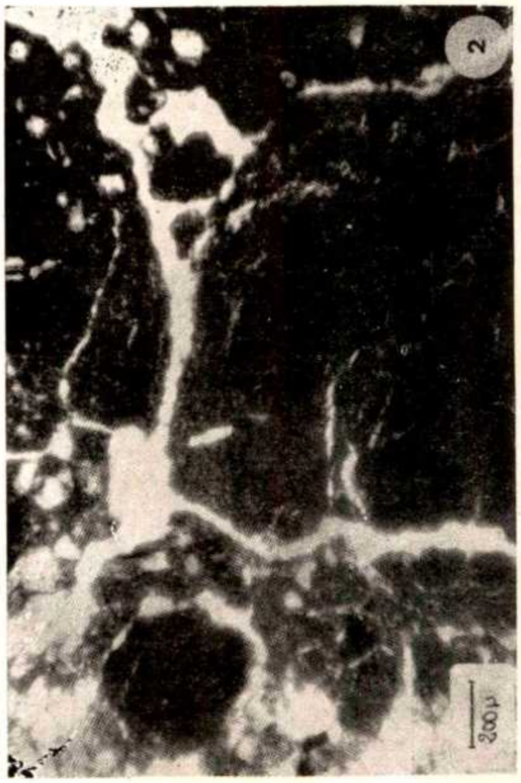
From bottom to top of this upper sequence the gradual increase of the quartz sand grain content is the consequence of an endless reworking of the same materials and results in a lessening of fertility of the soils developed over the last five thousand years.

Whatever the age and the characteristics of the parent materials the factors responsible for the soil development are: the biological activity, the translocation of fine particles from the surface within the soil through the action of water and the removal of calcium carbonate from the surface layers and its accumulation within the depth in relation with the evapotranspiration phenomena. These last two processes do not seem to modify in a significant extent the agricultural properties of the studied soils. The accumulation of calcium carbonate is never important enough to prevent the deep penetration of roots within the soil. Translocation of fine particles does not lead to different textured horizons as the soil is endlessly homogeneized by the soil fauna.

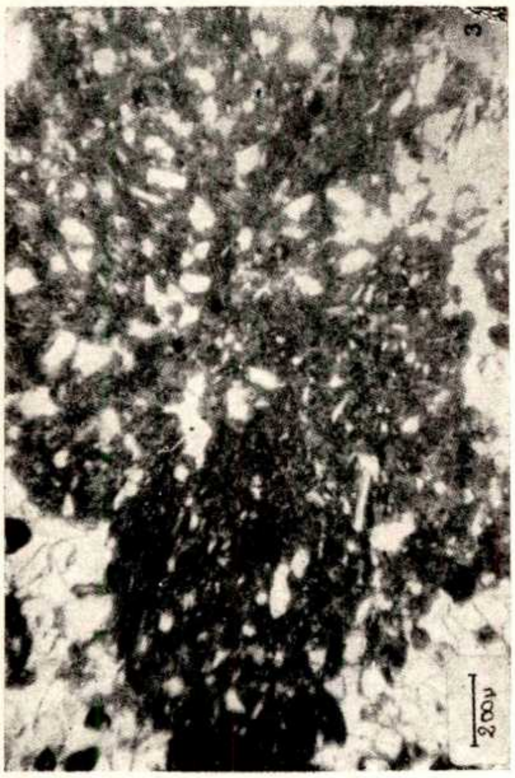
However there is a clear relation between the agricultural properties of the soils developed on the Ghaggar basin over the last five thousand years and the biological activity. In soil developed on fine alluvium the biological activity is very intense as these soils have a high moisture



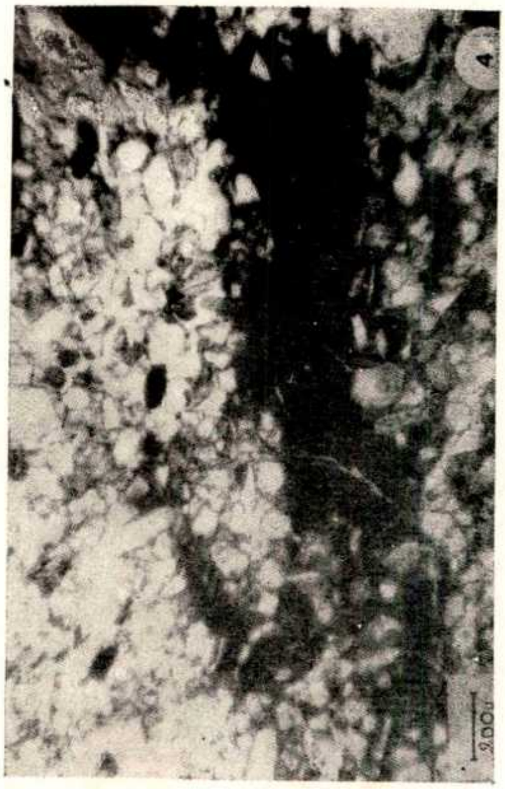
Courty : Micaceous alluvial Loam with subhorizontal orientation of mica flakes indicating a slow rate of deposition.



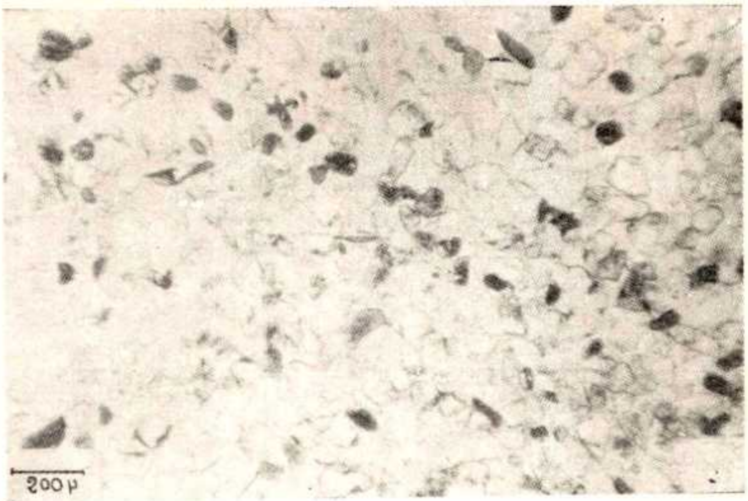
Courty : Very bine micaceous alluvium in depressions (flooded deposits).



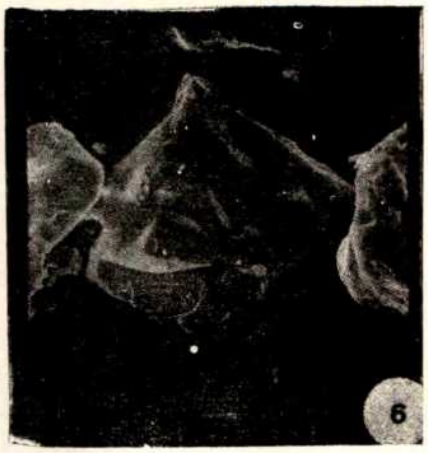
Courty : Homogeneization of sands reworked at the soil surface with fine alluvium due to biological activity.



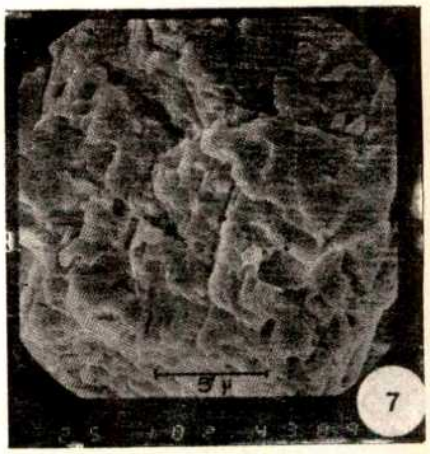
Court : Fine sand materials from ancient irrigation canals mixed with local micaceous fine fraction.



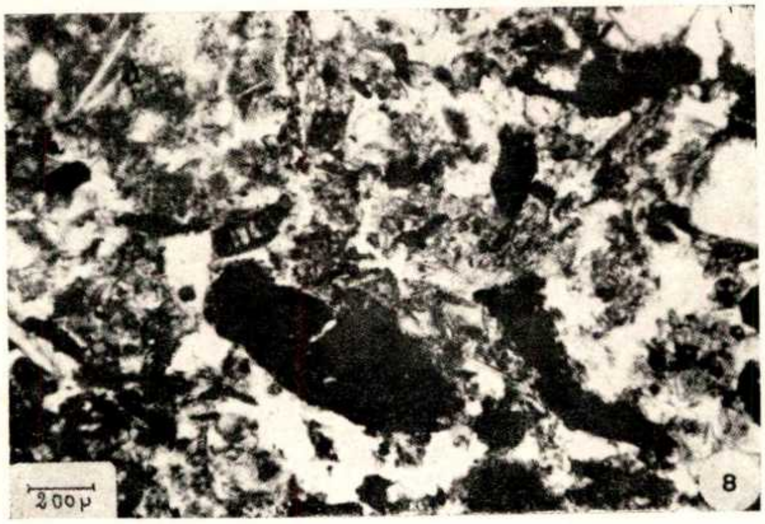
Courty : Loamy sand sediments from youthful dunes covering the ancient flood plain and consisting of quartz sand grians, rounded micas and calcium carbonate grains.



Courty : Weakly rounded shade quartz grain from sediments of Pl 5.

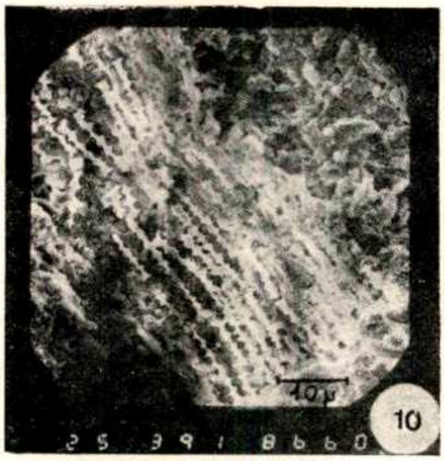


Courty : Weakly weathered feldspar grain from sediments of Pl. 5.



Courty : Ash layer at Mitathal rich in fine particles of charcoal and in phytoliths of the herbaceous type.

Courty : Silica Phytoliths from ashes of Pl. 8.



Courty: Graminae phytoliths from ashes of Pl. 8.

content and remain wet even during the dry season. Aeolian sands, accummulated at their surface during the dry season, are integrated to the soil through the biological activity. Such soils with a lighter texture in the upper horizons and nutrient and moisture reserves in the deeper horizons are very suitable for agriculture and can be easily cultivated with primitive tools. This type of soil was widespread during the Protohistoric period on the ancient flood plain. At the same period, the soils developed in the depressions were not so affected by wind and had a heavier texture. They were not so suitable for agriculture because too compacted during the dry season and affected by water-logging during the wet season.

The increased aeolian activity marked during the Protohistoric period affected soil properties. Biological activity was no longer able to integrate the sands accumulated at the soil surface and youthful dunes then gradually cover the former flood plain. Agricultural practices could have only accelerated the natural degradation of the soil texture because the natural vegetation was cleared out and soils were thus bared during the driest and windy season when no crop was growing.

These light textured soils were easily cultivated but as increasingly sandy they were consequently more filterable and irrigation of the land was essential to ensure two harvests per year. Also fine material and nutritive element reserves decreased and thus there was a noticeable lowering in soil fertility. Most part of the present-day soils developed on the ancient flood plain have such characteristics. The best suitable present-day soils for agriculture are those developed on the ancient depressions as their upper horizons are now sandier and have still a good fertility because of their high content in fine fraction and in micronutrient elements in the deeper horizons.

The study of the materials from the ancient irrigation canals confirmed the evolution of the landscape as previously established. In the most ancient ones, sands, consisting mainly of quartz grains, were mixed with fine micaceous fraction and indicated a reworking of local materials from the sandy embankment of river channels. These materials were very similar to the soils developed during the Protohistoric period. With time, the materials from the canals had a higher content in sands and in calcium carbonate which was clearly correlated with the evolution of the surrounding areas.

Most part of occupation layers in the tells consist of decayed mud bricks and ashes. Bricks were made up of a mixture of loamy sand, calcitic loam, micaceous clay, ashes, charcoal, fragments of fired bricks and ceramics. In the different studied sites all the sediments used for building materials had clearly a local origin and had properties very similar from the sediments met at the subsurface. They had a rather high content in salts which was never found in the sediments all around the area.

The bricks were disturbed and disaggregated by the combined effect of salt crystal enlargement and biological activity. Local action of water was also observed in some kind of puddles.

Ash layers were rich in small charcoal with diffuse shapes and had a high content in silica phytoliths in which Graminae type was clearly identified. Accumulation of phytoliths resulting from the decay of fresh graminaes was also common. Specific ashes of wood combustible were rare compared to the herbaceous ones.

The Protohistoric civilization became established on a huge stabilized alluvial plain across with a few channels still run and which probably functioned sporadically. Once flow stopped, aeolian activity became the main agent for reworking the landscape and soils. This evolution does not seem to be the consequence of a real increase in aridity due to natural causes within the last five millenia, Denudation by men could have accelerated the effects of aeolian erosion of the soil surface and thus the landscape alteration.

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Ethnoarchaeological Researches in North-West Rajasthan

V. Roux and A.K. Sinha

The Indo-French archaeological mission has undertaken ethnoarchaeological research work in North-West Rajasthan, which is focused on agriculture and on the way this area could have been exploited during the second millenium B.C.. The first campaign took place in July and August 1984 in Malkhaira, a village located near Bhadra 29°6′ latitute North, 75°13′ longitude East), district Ganganagar.

In this paper, we will look at the following :

the meaning of ethnoarchaeological studies ;

the scope and first results of our research.

1. Meaning of Ethnoarchaeological Studies

First of all, we will point out the fact that, in archaeology, our knowledge-frame work is an anthropological one : it is only thanks to the knowledge of certain situations observed in a specific place and at a specific time that we can interpret the archaeological data. For example, it is because we know that the outcome of a fire is ashes that we can deduce from ashes the presence of hearths. This kind of deduction is usually implicit in the texts and considered as common sense. They are nonetheless based on ethnographic analogies and should be considered as such. Binford expresses this very idea in these terms : "All our statements about the past are inferences relative to observations made on the contemporary archaeological record" (1981 : 23).

It is obvious then that anthropological literature is essential to archaeology :

it is a means of widening the range of reference, and therefore the range of interpretation ;

it is a means of estimating the validity of inferences. i.e. the validity of the anthropological analogies used in the archaeological constructions. However, the problem with anthropological literature is that it does not provide any information about the relation between the material data and the ethnographic data, being thus of little help for the archaeologists whose problems are basically concerned with how to infer ethnographic propositions from material data.

To solve this problem, i.e. the use of anthropological data from an archaeological perspective, the archaeologists have come up with ethnoarchaeological investigations : these are for studying the value of the material data (from artifacts to ecofacts) as a base upon which particular anthropological propositions can be built. In the field, material and corresponding ethnographic data are simultaneously noted down. These two kinds of data are contrasted and the value of the data of the first category for making inference s about the second category is then estimated. Thus, Binford (1981), studying bones, compares modern faunal assemblages derived from human behavior with ones derived from animal behavior, and assesses the value of the descriptive features to distinguish in archaeology the two kinds of assemblages. Kramer (1979) studies the value of the element "habitable surface area" to infer demographic data, by analysing relationships between these two elements in an

Iranian village. In the same way, the studies which deal with ecology (Gould, 1983, Yellen, 1977, Hole, 1979) are about the relationships existing between social or economic data and ecological data, and about the value of the latter to infer the former. Ethnoarchaeological investigations are, above all, a means of estimating the interpretation we can draw from archaeological data, both in terms of validity and in terms of conditions to produce them.

Our own research has proceeded in this way : on the one hand, we are concerned with the value of the agricultural material (tools and silos) for making inferences about ancient technology and agrarian systems. The study about tools will be published in the Indo-French first preliminary report (A.S.I., in press). On the other hand, we are concerned with the ecology of North-West Rajasthan and the hypotheses on past agricultural economy which can be drawn from it. In this paper, we will deal with this last aspect of our research.

2. Ethnoarchaeology in North-West Rajasthan

The study of past agricultural economy from ethnographic data is possible here because the necessary conditions for applying the principle of analogy are present : the Indo-French archaeological mission has demostrated that the present environmental conditions are comparable to the protohistoric ones : semi-arid climate and landscape (dried-up rivers and sand dunes) that crossed irrigation canals. The present and protohistoric environments being similar, deductions by analogy are then possible.

The vilage, in which we conducted our first campaign, Malkhaira, has been selected from among 15 others, according to the following criteria : closeness to archaeological sites and a canal, presence of traditional agricultural techniques, economy based on agriculture and a sizable population.

We will now give an account of the ethnographic data related to our topic, and then we will present the first hypotheses they can suggest about the past economic system in this area.

2.1. Ethnographic data

Malkhaira is a village of 3750 persons, located near the canal "Amersingh branch" and its lands cover 1524 hectares.

2.1.1. Exploitation of soils

In this area, the soil is of two types : loamy and sandy. The proportion between the two varies from one place to another. At Malkhaira, the lands with loamy soils total 1149 hectares and those with sandy soils 375 hectares.

The sandy soils are not irrigated, being unable to retain water. The loamy soils are irrigated but only partly.

(a) some tracts, being at a level higher than that of the canal, cannot receive any water ;

(b) the amount of water given per hectare is not sufficient (3 times less than should be necessary); therefore, the agriculturists, with the total amount of water allocated to them, irrigate only part of their land with the aim of having a minimum of land well irrigated.

Besides, damages to the canal can occur, and the quantity of water per hectare diminishes greatly. This is what happened in 1983. As a result, only a little more than half of the arable lands could be irrigated and exploited in that year.

Every year, the land actually cultivated in non-irrigated areas, as well as in irrigated areas, depends on rains. If the monsoon is good, maximum of land will be cultivated. If the monsoon is bad or a failure, then only a part of the irrigable area will be cultivated (that small fraction which requires all the available canal water to make a harvest possible).

2.1.2. Cereals cultivated

On sandy soil, the following are cultivated : gram (*Cicer arietinum*) *bājrā* (*Pennisetum glaucum*) *moth* (*Phaseolus acontifolius*), *mung* (*Phaseolus mungo*), and *gowār* (fodder plant).

On non-irrigated loamy soils, the following are cultivated : the plants mentioned above, plus colza (*Brassica campestris*) and *jowār* (*Sorghum vulgare*). On irrigated loamy soils, we can find : every plant mentionned above, plus wheat (*Triticum aestivum*), cotton, *methi*

(*Trigonella foenugraecum*) and *barsem* (fodder plant). These last plants have been Introduced in the region in 1950 at time of construction of the canal.

The distribution of the crops between irrigated and non-irrigated fields depends on every landowner and on the amount of land he owns in either category.

2.1.3. Agricultural cycle

The agricultural cycle is organized according to the rains which fall between the beginning of July and mid September.

TABLE 1

Rainfall in mm per month averaged for the years 1910 to 1965, at Bhadra (Rajasthan district gazetteers, 1972 : 20)

	J	F	*M*	*A*	*M*	*J*	*Jl*	*A*	*S*	*O*	*N*	*D*	*Average*
Bhadra	12.2	10.2	9.1	5.3	8.9	33.5	130.3	101.6	58.2	8.4	1.5	5.3	384.5

The different crops are sown :

- either at the beginning of the rains (beginning of July) and harvested in the autumn (between September and December depending on whether the lands are irrigated[1]. These crops are called *kharif* and include *bājrā, mūng, moth, gowār, jowār* and cotton (this last one is, as a matter of fact, sown at the end of April) ;
- or after the rains (October-November) and harvested in the spring time (March-April). These crops are called *rabi* and include wheat, gram, barley, colza, *methi* and *barsem*. Ploughings for the *kharif* cycle take place at the beginning of june, three weeks before the first rains (except for the ploughings of the cotton fields which take place between 15 April and 15 May). The only ploughings for the *rabi* cycle are held at the beginning of October or as early as August, depending on whether the fields have been planted previously with *kharif* crops.

As a general rule, all the non-irrigated areas of land have either *kharif* crops, whereas the irrigated lands produce a double crop (*kharif and rabi*) : on the irrigated fields, the *rabi* crops can come after the *kharif* crops, since the latter are harvested before October-November, when the soil is still humid enough for sowing. On the non-irrigated fields, *rabi* crops cannot come after *kharif* crops, the latter ripening only in November-December, when the soil is no longer humid enough for sowing purposes.

Whether on irrigated or non-irrigated land, no regular fallow system is used. The number of fallow in any year depends on the rains.

2.1.4. Output

The output is all the better in the irrigated land than in non-irrigated land, because chemical fertilizers, insecticides and high yield seeds are used. However, in both cases, they can vary considerably from one year to the other (table 2). In non-irrigated land the variation is mainly due to rains, to diseases, and in winter to frost. The minimum output given in table 2 corresponds to the one obtained in years of bad monsoon. In case of drought, there is of course no crop at all. In irrigated land, the variations arise not only from the factors already mentioned (the rains are also important since the irrgation is insufficient), but also from possible

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[1] On non-irrigated lands, *bājrā, mūng* and *moth* are harvested at the end of September, *gowār* at the end of October. On non-irrigated lands, *bājrā* is harvested in November, *gowār, mūng, moth* in December,

TABLE 2

Output of the main crops cultivated in Malkhaira (our own data)

CEREALS	*SEED kg/ha.*	*OUTPUT kg/ha.*		*SEED/YIELD RATIO*	
		Irr.	*Non-irr*	*Irr.*	*Non-irr.*
Bājrā	4	630 to 2690	158 to 1236	159 to 523	40 to 312
Gowār	16	505 to 1382	244 to 1185	32 to 87	15 to 75
Cotton	12	651 to 1580	—	55 to 133	—
Wheat	118	2370 to 3950	—	20 to 33	—
Gram	40	513 to 1580	395 to 1580	13 to 40	10 to 40

damage to the canal and then restriction of water. Yet, the output is never nil.

2.2 Ethnoarchaeological study

We will first summarize the main archaeological data relevant to agriculture for this area. They are quite sparse, since only two sites can provide some preliminary data : Kalibangan and Banawali. As far as the Harappan levels are concerned, the data have shown :

— wheat (*Triticum sphaerococcum*) at both sites (Vishnu-Mittre and Savithri, 1982);

— barley (*Hordeum sp.*) and gram (*Cicer arietinum*) at Kalibangan (Vishnu-Mittre and Savithri, 1982) ;

—the use of plough : in 1983, a terracotta has been discovered which represents without any doubt a plough (Bisht excavations, pers. comm.) We know also from the work of the Indo-French archaeological mission, that :

(a) irrigation canals have been built in the bed of the Chautang river along which Harappan groups settled (Francfort, Gentelle) ;

(b) the climate was already semi-arid, and the sandy soil present (Courty).

Taking into consideration these archaeological data and by reference to the ethnographic data obtained for the area, we can straightaway establish the following five points :

(1) In so far as wheat, barley and gram are the only known crops of the second millennium B.C., we can infer that, at that time, only *rabi* cultivation was done and only one crop per year was obtained ; the agricultural activities might have taken place between August, beginning of the ploughings, and March-April, the time of the harvests.

(2) The presence of wheat, barley and gram means that irrigable and non-irrigable land, whether loamy or sand, could be exploited.

(3) The wheat identified at Kalibangan is *Triticum sphaerococcum.* Despite its resistance to arid climate, we can suppose it was the plant cultivated on irrigated lands, barley and gram being more adapted to arid soils.

(4) However, barley and gram could have been also cultivated in irrigated areas as is the case in Malkhaira.

(5) The settlement of an important population in North-West Rajasthan during the second millennium B.C., and the presence of irrigation canals are two elements which can be correlated : without supply of water, *i.e.* without a guarantee of crops during the drought periods, the settlement of an important population is not

possible in the area. Indeed, if we look at the data given by the Census of India (1961), we can see that in 1901, the district of Ganganagar was inhabited by 143,442 persons, and in 1961 by 1.037,423 persons : this jump in population is correlated with the construction of the Gang canal and the Bhakra canal ; people from the adjacent states could come and settle down, irrigation securing them a basic agricultural output even in the case of a bad monsoon.

These points are interesting in the sense that they demonstrate how in this semi-arid area, protohistoric groups could have still depended on agricultural economy : they could exploit the whole land area and have a minimum of crops during drought periods. Our future research will aim at getting more precise estimates of past agricultural production.

Meanwhile, we can start with one of the economic aspect of the agriculture at the time : the circulation of cereals in the region. We will take into account the following ecological facts :

(1) When the rains are scarce or none, the irrigated lands are the only ones to produce crops.

(2) The surface areas of irrigated land vary from one place to another, according to the amount of land of which the level is higher than that of the canal, and as well as to the sandy surface areas.

(3) The rains can fall in variable quantities from one place to another, moistening in various proportions the cultivable surface areas, whether irrigated or not.

Using these ecological facts, it is then possible to set up for the past the following hypotheses :

during drought, agricultural productions would have been more or less deficient, according to the irrigable surface area surrounding the settlement ;

to cover up the regional imbalance of the agricultural production, due to drought or bad repartition of rains, a circulation of cereals between settlements might have existed ;

those communities in a position to redistribute cereals might have been the ones having more irrigable land, independent of their size or of the total surface area of the exploited territory. This last hypothesis is acceptable as long as we admit that during drought periods, the circulation of cereals was organized only according to economic imperatives.

These hypotheses are now to be worked out by a study on irrigable surface areas surrounding the archaeological sites : we will be then in a position to compare their agricultural production potential during drought period, and set up henceforth a map of the sites giving and receiving cereals during the periods of crisis (after having taken into accounf the ratio between the size of the site and the size of the exploitable territory). We will start that program this year (1985), in the course of the archaeological survey in North-West Rajasthan conducted by the Indo-French team.

CONCLUSION

We will summarize the main points our ethnoarchaeological investigations havc put forward :

(1) In North-West Rajasthan, during the 2nd millenium B.C,, the presence of irrigation canals along with a large population are two elements which can be correlated.

(2) Only one crop was on hand, at spring time : the irrigated and non-irrigated lands, whether loamy or sandy, could be exploited thanks to the simultaneous cultivation of wheat, barley and gram.

(3) In period of drought, or of bad distribution of rains, cereals might have circulated from one settlement to the other according to a circuit we might be able to mark out again by comparing the size of irrigable territory shown for each site.

Ethnoarchaeological investigation has enabled the acquisition of local knowledge essential for the enrichment of our interpretative hypotheses. Although the results presented here are tentative and are related to the beginning of our research, we hope however that we have been able to show how ethnoarchaeology can be useful in archaeological constructions, and how it is an important tool of analysis.

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The Assam-Burma Route to China

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The Postulate

The starting point of the present discussion is P.C. Bagchi's analysis in *India and China, a Thousand Years of Cultural Relations* (Bagchi 1951). Bagchi (1951:6) dates the first arrival of the Buddhist missionaries in China via the central Asian route in 65 A.D. According to him it is improbable that the Chinese rulers knew about Buddhism before 2 B.C. when Buddhist texts and images were presented to the Chinese court by the Yue-che rulers. In this context he adds, "South China however seems to have come into contact with India a little earlier and in an independent way" (Bagchi 1951 : 7).

The sources adduced by Bagchi to prove this point are not very clearly set forth but these seem to be the following. First, Chang-Kien, a Chinese envoy in central Asia in the second half of the second century B.C., found that "bamboo and cotton stuff from the southwestern provinces of China" (Bagchi 1951 : 5) were being sold in Bactria. According to Chang-Kien's information these materials were brought by caravans from India. Secondly, Bagchi (1951 : 7) points out that the term *China*, derived from the name *Tsin* given to China under the Tsin dynasty (221-206 B.C.), occurs in the Mahābhārata which, according to him, "substantially is a compilation of about the same period". Thirdly, Bagchi draws attention to what he calls the migration of Indian stories to China at an early date.

"Traces of them are found in the writings of a Chinese author named Huai-nan-tseu also known as Prince Liu Ngan who lived in the second century B.C. The author speaks of the great Yū who, 'while going to the country of the naked people left his clothes before entering it and put them on when coming out, thus showing that wisdom can adapt itself to circumstances'. The story is reminiscent of a Buddhist legend which tells us that the Bodhisattva did a similar thing while going to trade with the country of the naked people. The story migrated to China directly or through the intermediary of some bordering people" (Bagchi 1951 : 7-8).

Fourthly, Bagchi (1951 : 8) states that there is evidence to show the presence of Buddhist missionaries in south China by the middle of the first century A.D.

In the section on "overland routes—Tibet and southwest China" Bagchi (1951: 17) describes the Assam-Burma route to China.

"The Assam-Burma route to China started from Pataliputra (Patna) which was the ancient capital of India, passed by Champa (Bhagalpur), Kajangala (Rajmahal) and Pundravardhana (north Bengal) and proceeded up to Kamarupa (Gauhati) in Assam. From

Assam the routes were three in early times as now : one by the valley of the Brahmaputra up to the Patkoi range and then through its passage up to upper Burma ; the second through Manipur up to the Chindwin valley ; and the third through Arakan up to the Irrawaddy valley. All these routes met on the frontier of Burma near Bhamo and then proceeded over the mountains and across to river valleys to Yunnanfu, i.e. Kunming, which was the chief city of the southern province of China" (Bagchi 1951 : 17).

To substantiate the issue of the Assam-Burma-south China route Bagchi also refers to the testimonies of Yi-tsing and Hiuen-tsang both of whom belong to the 7th century A.D. Yi-tsing in the 7th century A.D. reported that twenty Chinese monks had come to India in the middle of the 3rd century A.D. by the Yunnan-Burma-Assam overland route and that a monastery was built for the use of these monks near Bodhgaya by King Śrī-Gupta who was an ancestor of the Gupta emperors of the 4th century A.D. The ruins of this monastery, known as Chīna Saṅghārāma, were seen by the Chinese pilgrims in the 7th century A.D. (Bagchi 1951 : 60). The testimony of Hiuen-tsang (Bagchi 1951 : 17) related specifically to Kamarupa. The Chinese pilgrim there learnt that the southwest borders of the Chinese province of Sse-chuan were distant by two month's journey, although the route was a difficult one because of the high mountains, pestilential vapours and poisonous snakes and herbs. Bhāskaravarmaṇa, the contemporary king of Kamarupa, was familiar with the exploits of the early rulers of the Tang dynasty of China (618-907 A.D). Hiuen-tsang also found that a Chinese song commemorating the victory of the prince of Tsin, the second son of the Tang emperor Kao-tsu, over the rebels in 619 A.D. was very popular in Kamarupa during that period. The fact that a Chinese song composed after 619 A.D. could be popular in Kamarupa before 638 A.D., the date of Hiuen-tsang's visit to that area, shows, according to Bagchi (1951 : 18) that "notwithstanding the difficulties in communication the intercourse between Eastern India and Southwestern China was very close and intimate".

The evidence of Chang Kien, which was referred to by Bagchi (1951), has been cited in detail by Joseph Needham.

"When I was in Ta-Hsia (Bactria), I saw there a stick of bamboo from Chiun (Chiun-chow in Szechuan), and some cloth from Shu (Szechuan). When I asked the inhabitants of Ta-Hsia how they had obtained possession of these they replied, the people of our country buy them in Shen-Tu (India)'. Shen-Tu may be several thousand *li* to the south-east of Ta-Hsia. The people there have fixed abodes, and their customs are very much like those of Ta-Hsia, but the country is low, damp, and hot. The people ride on elephants to fight in battle. The country is close to a great river. According to my calculation, Ta-Hsia must be 12000 *li* sonth-west of China. Now the country of Shen-Tu being several thousand *li* to the south-east of Ta-Hsia, and the produce of Shu being found there, that country cannot be far from Shu" (Needham 1979 : 114).

It is interesting to note that Needham makes the following comment on the general significance of this route.

"While small quantities of goods probably came over it from very ancient times, its difficulties were such that an important expedition sent out at his suggestion by the emperor Wu Ti, to find a way round to Bactria without having to cross either Hunnish or Tibetan territory, "had to be abandoned, in spite of heavy expenses incurred" (Needham 1979 : 174).

This cautionary note notwithstanding, Needham (1979) in his map describing the Chinese routes of the time shows two lines linking the Gangetic valley and China. Both of them emanate from the ancient Pataliputra area, one going over the Tibetan plateau, and another moving towards north Burma through Assam. As far as the Tibetan route is concerned, it may be advisable to remember what Bagchi wrote about the antiquity of this route.

"The route through Tibet was opened in the second quarter of the seventh century when the first king of the united Tibetan states, Srong-btsan Sgam-po, was converted to Buddhism and allied himself with China and Nepal by marrying a princess from each of the two countries. From this period Indian and Chinese missionaries began to pour into Tibet...A friendly Tibet also helped in the passage of the Buddhist missionaries from India to China and the Chinese pilgrims from China to India" (Bagchi 1951 : 18).

It is also important to note that the routes from India to Tibet extend from the portion adjoining Ladākh on the one hand to the modern Arunachal province on the other. There are many routes and as Bagchi emphasizes, they come into clear historical focus only from the 7th century A.D. onwards. The basis of Needham's postulate of an early Tibetan route to the Gangetic valley is apparently his idea that Ptolemy in his *Geography* (first half of the second century A.D.) mentioned the Tibetan plateau. Even if this idea is correct, this may not be sufficient to suggest an early historic trade-route to the Gangetic valley across the Tibetan plateau. An additional piece of evidence suggesting such a route over the Tibetan plateau has also been sought in the following record in *Periplus of the Erythraean Sea* which can be dated around 60 A.D. This record occurs immediately after Periplus makes a reference to Chryse which is generally identified with the Malayan peninsula (section 63 in Periplus).

"A land called This, there is a very great inland city called Thinae, from which raw silk yarn and silk cloth are brought on foot through Bactria to Barygaza, and are also exported to Damirica by way of the river Ganges" (section 64 of Periplus, cf. Schoff 1912 : 48).

The "land called This" has been identified by W.H. Schoff (1912 : 261) with "the great western state of China, Tsin". The "city called Thinae", according to Schoff (1912 : 261), was its capital, "Hien-yang, later known as Si-gnan-fu, on the Wei river not far above the confluence with the Hoang-Ho, in the present province of Shensi". This identification of the city called Thinae contrasts strongly with the identification proposed by M. Cary and E.H. Warmington (1963) for this city. Thinae has been identified by them with Theinini, probably in the Salween valley in Burma (Cary and Warmington 1963 : 106). On the other hand, Chen Qian (1981), a Chinese scholar, identifies Thinae with Changan, the capital of both the Tsin and the Western Han dynasties. The point is that there is obviously a serious problem about the identification of certain geographical terms used by Periplus. This point is also driven home by Schoff's annotation of "to Damirica by way of the Ganges". Schoff writes :

"This was the route across the Tibetan plateau, starting in the same direction as the Turkestan routes, from Singanfu to Lanchowfu ; branching here, it led to Siningfu, thence to Koko-Nor, and southwestward, by Lhasa and the Chumbi vale to Sikkim and the Ganges" (Schoff 1912 : 272).

One would say that this annotation is entirely an exercise in speculation. Damirica denotes the Tamil country and "to Damirica by way of the Ganges" may suggest that the goods were first taken down to the Ganges mouth and then shipped to the Tamil coast. Otherwise the route to Damirica by way of the Ganges cannot have any meaning because of the distance involved between Damirica and the Gangetic valley. Now, to come to the Gangetic valley from China one does not have to come through Sikkim and the Chumbi valley. It is perfectly feasible to come to the Panjab area first and then travel down to the Ganges. We would argue that the reference to "Damirica by way of the Ganges" does not imply the route across the Tibetan plateau.

One may also note that among the Indian writers on ancient Indian trade-routes Moti Chandra (1977) accepts the idea of an early historic trade-route from the Pataliputra area to China through Assam and north Burma but is not altogether convinced of its importance mainly in view of what he calls "the difficult nature of the terrain".

Chen Qian (1981 : 134) has extensively quoted from the records of Jia Dan (730-805 A.D.) who obviously wrote a book called *Passages to Foreign Countries from the Border Prefectures*. This very clearly describes the contemporary route from Yangjumie town (modern Dali in Yunnan) to Burma and India. The description, as cited by Chen Qian (1981), is worth quoting in detail (the identification of areas and places mentioned within brackets is given by Chen Qian).

"The road leading westward from Yangjumie Town (Dali today) to Yongchang Prefecture (Baoshan today) measures 300 *li*. The section of the route leading from Yongchang to Zhugeliang Town (on Mount Gaoligong near Tengchong today) measures 200 *li*. The section leading southward to Lecheng Town (within the borders of Longling today) measures 200 *li*. The route then enters the borders of the Pyu kingdom. Passing through the eight tribal settlements of Wangong (the ancient town of Taigong, not far from the juncture of the Ruili River and the Irrawaddy River) and others, it comes to Xili Town, measuring a distance of 700 *li*. The section of the route to the Pyu kingdom (Prome today) via Tumin Town, measures 1000 *li*. Here the route leads away from the Pyu Kingdom westward and, crossing Heishan, comes to Kamarupa in east India (Manipur of India today), measuring a distance of 1600 *li*. From there it turns northwest and, crossing the Karatoya River, reaches Pundravardhana (which ought to be on the middle-lower reaches of the Brahmputra river today), a distance of 600 *li*. The route then leads to the southwest and comes to Kajingala (Bangladesh today) on the south bank of the Ganges River in the western part of central India, extending a distance of 400 *li*. Next it turns westward and reaches Magadha, covering a distance of 600 *li*. The other route leads westward from Zhugeliang Town to Tengchong, a distance of 200 *li*. Then it turns to Michong (today Guyong in Tengchong), a distance of 100 *li*, and having crossed the mountains comes to Lishui Town (in the vicinity of Mitkyina in Burma). Here the route extends westward, crossing the Lishui and the Longquan rivers, and comes to the town of Anxi (today Mongaung in Burma), covering a distance of 200 *li*. Then it turns westward again, and crossing Mino river reaches the Daqin Brahman kingdom (the northeast part of Assam in India). The route extends further west and, crossing big mountains, comes to the kingdom of Gumolu on the northern border of east India, a distance of 300 *li*. Finally it turns to the southwest and comes to Pudravardhana on the northwest border of east India, covering a distance of 1200 *li*. Here it joins the route that extends from the Pyu kingdom to the Brahman Kingdom" (Chen Qian 1981 : 134-135).

The importance of such an explicit testimony is obvious, and as Chen Qian writes :

"According to the above information, there were two routes leading from Chengdu in Sichuan to India via Burma. Both routes start in Chengdu, and pass through Xichang, Dali and Baoshan to the town of Zhugeliang, located on Mount Gaoligong within the borders of Tengchong. Here the two routes divide. The southern route goes from Zhugeliang through Longling and Ruili comes to the Shan Kingdom of Burma. It goes on to Prome, the ancient capital of Pyu, via Taigong. Finally, it passes Manipur within the borders of India, and reaches India proper through the valley of the Brahmaputra River in Assam. The total distance is 8534 *li*. The northern route leaves Zhugeliang and comes to Mitkyina and Mongaung via Tengchong. Crossing Naga Hills, it comes to the northeast part of Assam, and finally reaches India along the middle and lower reaches of the Brahmaputra river. The total distance of this route is 7634 *li*" (Chen Qian 1981 : 135).

Jia Dan's book is said to have been written in 801 A.D. (Chen Qian 1981 : 136) and thus, by the beginning of the ninth century A.D., the Yunnan-Burma-Assam route may be said to have assumed a well-defined direction. The testimony of Hiuen-tsang in the seventh century A.D., cited by us earlier, also shows the existence of these links in that period. However, the problem in the present context is to determine the extent to which the antiquity of this route can be pushed back earlier. It has already been noted that there is a reference in I-tsing (7th century A.D.) to twenty Chinese pilgrims who travelled along this route to Magadha in the third century A.D. The only reference in favour of this route before the third century A.D. is Chang Kien's record of the presence of bamboo and cloth (cotton or silk) from southwest China in Bactria through India in the second century B.C.

It is also important to observe that Classical sources do not throw any light on this route. As we have seen, the idea of the Chinese goods reaching the Gangetic valley across the Tibetan plateau in the early centuries A.D. is not in any way convincing.

The Indian Sources

The main purpose of this section is to assess if there is any supporting evidence of this trade-route on the Indian side. The first category of evidence relates to the presence of Kirātas and Chīnas in the army of Bhagadatta who has been mentioned as the king of the Brahmaputra valley in the Mahābhārata (Chapter 25, *Sabhāparvam*). The reference occurs in the context of Arjuna's *digvijaya* or universal conquest. In the battle with Arjuna Bhagadatta, the king of Prāgjyotiṣa, was found with a multitude of warriors belonging to Kirāta, Chīna and the coastal belt of the sea.

Among other early Indian references to China one notes the Arthaśāstra of Kauṭilya and the Manusmṛiti. In the Arthaśāstra (2.11.114) the following reference occurs : "By that are explained the silk and silk cloth from the land of Chīna" (tayā kauṣeyaṁ Chīnapaṭṭāścha chīnabhūmijā vyākhyatāḥ).

In Manu 10.44 the chīnas are mentioned along with the pāradas, pahlavas, kirātas, daradas and khaśas (pāradāpahlavāśchīnāḥ kirātādaradaḥ khaśaḥ).

In the Arthaśāstra there is another reference to chīna: the sāmūra, the chīnasī and the sāmūlī are from Bāhlava (sāmūraṁ chīnasī sāmūli cha vāhlaveyaḥ). All these denote some kinds of yarns. In his note R.P. Kangle (1963 : 118) identifies Bāhlava with Bactria and cites K.P. Jayaswal to the effect that a central Asian fur is still known as sāmurā and still imported into India.

In his note on the Arthaśāstra 2.11.114 Kangle (1963 : 120) draws attention to the opinion of Jayaswal who "argues that chīna refers not to China but to Shīna, the Gilgit tribe, which still carries on silk manufacture. "The chīnas are mentioned along with the Daradas and other Himalayan or northwestern people and it is considered unlikely that chīna alone can" jump over thousands of miles away into China". If however chīnasī yarn came from Bactria (2.11.88) chīna is more likely to connote China proper.

The value of these references is severely limited by the fact that they are chronologically uncertain. None of these texts, the Mahābhārata, the Arthaśāstra and the Manusmṛiti, can be precisely dated. There is absolutely no way of claiming that these references to China date from the period when the central Asian route from China to India did not develop and that these references consequently imply a link with China through Assam and Burma.

The uncertainty of such references seems to find an echo in the absence of a well-defined early historic period in Assam. It is not possible to carry the authentic political history of Assam beyond the fifth century A.D. when the local inscriptions appear, or at least beyond the fourth century A.D. when the area apparently finds a mention in the Allahabad pillar inscription of Samudragupta. Despite references to Assam in the Mahābhārata and the Arthaśāstra (where the Lauhitya or the Brahmaputra river is clearly mentioned) there is not a scrap of archaeological evidence to show an early historic occupation level in the Brahmaputra valley and the adjacent region. This is all the more baffling because Pundravardhana with which the Brahmaputra valley had a close contact, at least in the later historical period, has an occupation level reaching the third century B.C. (cf. Mahasthangarh inscription and the archaeological remains at the site). The chronology of the Bhauma-Naraka dynasty to which Bhagadatta is supposed to have belonged (for this and related issues, Lahiri 1983) is totally uncertain. The earliest historic remains of Assam are the ruins at Dah Parbatiya near Tezpur (5th century A.D.), whose sculptures speak of the Gupta idiom and are reminiscent of the life-size terracotta figures found at Ahichchhatra in U.P. (Dasgupta 1980 : 4).

On the basis of the excavations at Ambari in Gauhati T.C. Sharma (1980 : 80) has postulated the existence of regular trade-routes from China to India through the Brahmaputra valley. Sharma's hypothesis is based on the presence of pottery designated "Ambari ware" which has been found in Period I (7th—13th centuries A.D., dated by radiocarbon method). Made of Kaolin or Chinese clay this pottery is according to Sharma, made of the same clay used for making pottery vessels and terracotta art objects in China. On the basis of surface colour, beside the Kaolin white, four other classes of pottery have been found—buff, red, grey and dark grey to black. Excavations at Ambari have also revealed, according to Sharma, Chinese celadon ware. However, the point to note is that the earliest Ambari belongs to the 7th century A.D. It is not an early historic site.

P.C. Choudhury (1959) tries to show that Assam was known to Periplus and Ptolemy.

"It appears from the accounts of both the Periplus and Ptolemy's geography that their authors knew something of the geography and peoples of Assam and that during the 1st-2nd century A.D., if not earlier, the land was known as Thina or Seres and extended from the extreme Sadiya region to southeast Bengal" (Choudhury 1959 : 38).

A perusal of the texts of Periplus and Ptolemy will show that there is no basis of such an arbitrary identification.

Interestingly enough, the collective testimony of the thirty-two Assamese inscriptions between the 5th and

13th centuries A.D., which contains the bulk of the historical source-material of the period, goes against any close Chinese or Burmese link. The place-names of different regions outside Assam, occurring in these inscriptions is substantial in number, and what is interesting is that they do not invoke China or Burma in any way. There is, in fact, no reason to doubt that throughout the course of her early documented history, the Brahmaputra valley looked towards inner India ranging from the Deccan and Karnataka on the one hand to Kashmir and Kamboja on the other (for the details, Lahiri 1983).

One is aware that in the prehistoric context which in the case of Assam remain undefined because of the lack of suitably dated sites similarities have been adduced between certain Assamese and Chinese and southeast Asiatic neolithic tool-types (cf. facetted tools, shouldered and tanged axes, wedge blades, etc.). The Assamese neolithic is supposed to belong to the east Asiatic tradition (for the details, Dani 1960 ; Sharma 1980). But it is worth remembering that there is no date for the Assamese neolithic and that neolithic tools are known to have survived in Assam till the nineteenth century A.D. This is not to suggest that there can be no early neolithic in Assam but to underline the point that there is no substantial dated data on the Assamese neolithic except a wide variety of tool-types. Mere comparisons with Chinese or southeast Asiatic materials are unlikely to lead us anywhere.

Thus, as far as the Indian sources are concerned there is nothing tangible to show the antiquity of the Assam-Burma-China route as far back as the second century B.C. The presence of Chinese celadon ware and the use of kaolin clay in the seventh century A.D. at Ambari is interesting in the sense that it shows the clear archaeological evidence of a Chinese link only in the context of the seventh century A.D. This is the period when the Assam-China link becomes well-defined in the Chinese sources too. Beyond this the situation is shadowy and made even more complicated by the absence of a dated early historic horizon in Assam. Even the significance of the clearly marked Chinese link from the 7th century A.D. onwards is minimised to some extent by the absence of any reference to China and Burma in the Assamese inscriptions between the 5th and 13th centuries A.D.

So, Chang Kien stands isolated. His testimony has not been corroborated by any specific historical or archaeological evidence which one can accept without any question. At the same time it might be wrong to deny that there could be some kind of trade between Assam and China through Burma even in that period. That trade was unlikely to have been an organized one but some Chinese goods could have filtered through. The situation is somewhat reminiscent of what Bakhtiyar Khilji of Lakhnauti found out about the contemporary trade with Tibet. In the *Tabaqat-i-Nasiri* of Minhaj-uddin-Siraj it is stated that Muhammad Bakhtiyar Khilji of Lakhnauti (Gaur in Bengal) decided in 1243 A.D. to invade Tibet. On the way he halted at the house of one of his ex-employees who informed him of the existence of thirty-five mountain passes between Kamarupa and Tibet. Bakhtiyar Khilji was also informed that the horses which were brought to Lakhnauti came through these passes. Khilji himself had not realized the existence of this trade, even though Lakhnauti happened to be its terminal point.

We suggest that the Gangetic valley—Assam-Burma-Yunnan route was not a line along which systematic and organized trade was conducted for any significant length of time. The geographical feasibility of this trade need not be denied but it is doubtful if the quantum of this trade was ever significant. This is also something which is suggested by the early British records on Assam. The situation which they depict in connection with this trade is unlikely to have been much different in earlier times.

The British Records

On the issue of routes between Assam and China there are two important nineteenth century publications, both by John M'Cosh of the Bengal Medical Service. In 1837 (M'Cosh 1975) he published a book, *Topography of Assam*, in which there is a discussion on the routes between Assam and south China. In *Proceedings of the Geographical Society of London* in 1861 (M'Cosh 1861) he wrote an article specifically devoted to this issue—"on the various lines of overland communication between India and China". He mentions five routes, taking care to add that these were not traversed by any living Englishman and that the information, thus, was drawn from very limited sources.

The first route was across the pass of the Dihong. The Dihong is said to be the "main tributary of the Brahmaputra", the termination of the great Tibetan river Tsan—pu. Pilgrims passing by this route reach Mah-loo, a frontier town of Tibet, in sixteen days. Four more days' journey away is a populous city with a regular Chinese government, called Rho-shee-mah. The Dihong pass is said to be always difficult and impracticable except in summer.

The second route is called the Mishmee route. It leads for a couple of days up the Lohit to where the river ceases to be navigable and "thence by a footpath ten days further along its banks, to a place very sacred in Hindu mythology, called Brahmakund. Great number of Hindu pilgrims go there for absolution." Tibet was within easy each from Brahmakund. This route is said to be very practicable, although it is added that little commerce is likely to flow along it.

The third route is by the Phungan pass to Manchee and China. This is said to lead over the Wang-leo-bum mountain range at an altitude of 8400 feet, through a dense jungle of oak, pine, rhododendron and juniper where no footpath can be seen and where two British travellers, Wilcox and Burlton, were led by their guides following the notches in trees, which they made in an earlier journey. This route leads to a point in the upper-reaches of the Irrawaddy, where the river is fordable.

The fourth route is by the Patkoy pass to Bhamo and thence to China. This is the route which was followed by the invading Burmese army in 1821-22. This is also said to be "by far the most practicable line from Assam to China".

"At Bhamo it meets a great stream of Chinese commerce between that country and Burma. Caravans of thirty and forty mules or bullocks constantly arrive. About five hundred Chinese are said to come every year to Bhamo and transact business to an amount of 700000 £ ... Although we have no British account of the Patkoy range, it is clear that little difficulties can exist there, since the entire Burmese army succeeded in traversing it. The Chinese exports that pass Bhamo are gold and silver ingots, brass and copper vessels, mercury, arsenic, vermillion, carpets, fans, silk fabrics, spices, rhubarb, musk, dried fruits, etc. The return cargo is cotton wool, ivory, edible birds' nests and British woollens and calico" (M'Cosh 1861 : 49).

The following extract from M'Cosh's earlier publication in 1837 is also helpful in understanding the line of this trade.

"The line of trade after leaving Suddia passes by Bisa across the Patkoy range of mountains and through the valley of Hookoong, to the town of Moon-koong, situated on a navigable branch of the Irrawaddy called Namyang. Merchants proceeding from Moon-koong to Ava at once descend the Irrawaddy to the capital; while those to China ascend the Irrawaddy for many miles, to a place called Cat-mow, where they disembark their goods and thence convey them on mules over a range of mountainous country inhabited by Shans (subject to Ava) into the Chinese province of Yunnan" (M'Cosh 1975 :11).

A good idea of the Bhamo route to Yunnan, on the Burmese side, may be obtained from *Gazetteer of Upper Burma and the Shan States, Part II, Vol, I,* published in 1901 (Scott 1901). Colonel E.B. Sladen led a mission from Mandalay to Mong Myen (Mo-mein) in Yunnan in January 1868 to examine various conditions related to this route.

"It was discovered that there were three routes in use between Bhamo and China. Between Bhamo and Mong Myen (Mo-mein) lies a range of hills running north and south, forming a spur from the Himalayas. Bhamo is on the west of the spur and Mong Myen on the east, and the range is pierced by three valleys, along each of which passes a trade route. The northern, Santa valley or Pon-laing route, is formed by the Tapin river, joining the Irrawaddy four miles above Bhamo. The centre, Hotha valley or "Embassy" route, is formed by the Namsa, a tributary of the Tapin, which it joins at a point about forty five miles east of Bhamo. The southern or Sawadi route follows the valley of the Nam Wan, which takes its rise in the Shamataung range. The northern route was considered to be the best... .." (Scott 1901 : 62-63).

There was a marked British interest to establish an easy route to south China from India and Burma in this period. Nowhere is the motivation behind it more clear than in a publication by Clement Williams, Agent to Chief Commissioner, British Burma, in 1864—"memorandum on the question of British trade with western China", published in the *Journal of the Asiatic Society of Bengal* of that year (Williams 1864). This publication is accompanied by two maps, one on the proposed route and the other on north Burma's links with China.

"The Taiping rebellion by impeding as it must do, the commerce between the western province of Yunnan, Sechuen and Queicho, and the eastern seaboard, encourages the attempt to pierce those provinces from the west. They form a splendid field, most inviting to the spirit of enterprise that of old has characterised our commerce. There are forty millions of people waiting to be clothed with British piece-goods, and to be furnished with the handiworks of all the manufactories of England, and ready to give, in return, silk, tea and the most valuable of the useful and precious metals, from mines that European skill would make many-fold more productive than now" (Williams 1864 : 432-433).

It now remains to mention that the fifth route described by M' Cosh (1861) was through Manipur. The route, called "an excellent opening", led from Manipur to Monfu on the river Ning-tee or Kyan-dwen, thence to Bhamo and finally, "up the Pinlang river into Yunnan".

The nineteenth century British records are thus quite explicit about the routes. It must, however, be remembered in this context that the routes basically outline only the geographical possibilities. What is more important in a historical investigation is to try to find out if these geographical possibilities were taken up at all, how they were exploited and what is the evidence of the necessary implications, or their absence as the case may be, in the historical records. The major historical questions are, in fact, the extent and nature of the trade, the kinds of contact and their significance which can be postulated for these routes.

Two points clearly emerge out of the British records. First, the routes mentioned so systematically by M'Cosh were not regularly used for trade, and secondly, whatever trade was conducted, it was more or less in the pattern of the intercommunity barter system.

The fact that these routes were not regularly used for trade may be emphasized by referring to two instances. Around 1869 the route to Burma through the Hookoong valley had become jungle-infested and fallen into general disuse. H.L. Jenkins, while travelling along this route in about this period, remarked on the paucity of trading parties along this trail. He could spot only three groups coming from Hookoong into Assam. The route seems to have been circumvented at that point of time (Jenkins 1978 : 250). It may be remembered that this Hookoong valley route was across the Patkoi range and that, according to M'Cosh (1837 : 11) this route across the Patkoi was among the most important lines of communication between Assam and north Burma. It should also be useful to remember that Pemberton whose report was first published in early 19th century noted the termination of a brisk trade with the Chinese merchants from Yunnan in Manipur (Pemberton 1966: 35). The three other routes described by M'Cosh suggest, by the very nature of his description, that none of them was effectively usable for organized trade. He himself could not record any significant evidence of trade along these routes.

The nature and extent of trade have been clearly mentioned by Pemberton in his *Report on the Eastern Frontier of British India* (Pemberton 1966). The following example is particularly suggestive. Pemberton mentioned the presence of certain "Meerwaree merchants from the west of India at Suddiya. They imported broad cloths, muslin, long cloths, coloured hankerchiefs, chintzes and various other descriptions of cloth, among other things. These articles were *bartered* (italics ours) to the neighbouring tribes from whom they got gold dust, and gold, ivory, silver, amber, musk, *daos* and also a few Burmese clothes and some small Chinese boxes (Pemberton 1966 : 74). He also mentioned the presence of bell-metal gongs and *Kurtals* of Yunnan in almost all the hill villages of the eastern frontier. It is barter and not organized trade which led to the distribution of Chinese objects along that frontier.

The significance of this kind of trade was very tellingly summed up by G.T. Bayfield who belonged to the Medical establishment of Fort St. George in Madras. In 1836 he was instructed by Lieutenant Colonel Burney, British Resident in the court of Ava, to undertake a journey from Ava to the frontiers of Assam and collect information on, among other things, "the extent and nature of the trade now carried on between China and Burmese dominions and between them and our territories in Assam, and the best mode of protecting, facilitating and extending the last mentioned" (Bayfield 1978 : 134). Bayfield observed.

"Before a profitable or important trade could be established a great revolution in their (i.e., of the tribes in this area) habits and mode of life must take place...Of the practicability of opening the communication I entertain no doubt, but of the immediate profitableness, considerable" (Bayfield 1978 : 222).

Bayfield obviously realized that any meaningful trade required a particular kind of socio-economic set-up which depended in some ways on the objects being traded or even benefitted in a significant way from a particular volume of trade. There is no evidence to suggest that trade was a very important element in the life of the hill people in the area between Assam and Burma or China. Regarding the regional trading activities O.H.K. Spate wrote:

"Normally they contribute little or nothing to the economic life...as indeed why should they? Millet, maize, dry hill rice, buckwheat, sugar-cane, tobacco; buffaloes, goats and poultry; and the innumerable products of the jungle, from bamboo to honey and wax, provide them with the essentials of an existence not without culture... routes across the hills, until the war, were for the most part mere trails..." (Spate 1954 : 559).

Trade, in fact, does not seem to be significant in the Assam-Burma-China relationship even in the nineteenth century.

CONCLUSION

With the postulate of an early historic trade route between the middle Gangetic valley and south China through Assam and north Burma as its starting point, the present paper has tried to explore the historical ramifications of the Assam-Burma-Yunnan route. We have, hopefully, demonstrated that barring Chang Kien's second century B.C. report of Szechuan bamboo and cotton (or silk) stuff being traded through India to Bactria and I-tsing's reference in the seventh century A.D. to twenty Chinese monks travelling by this route to Bodhgaya in the third century A.D., there is nothing to suggest that this route was in vogue in the late centuries B.C. or the early centuries A.D. Both these reports are from the Chinese annals, and on the Indian side, the references to Chīna in the Arthaśāstra and the Mahābhārata do not throw any unambiguous light on the date and mechanism of contact suggested by these references. There is no way of claiming that these references are in the context of the late centuries B.C. and that, as the Silk Route did not develop by then, they reflect Chinese contact along the Assam-Burma-Yunan line. In the context of Assam the most important point to remember is that there is no clear, documented history of the region till the fifth century A.D. when the local inscriptions first appear. The inscriptions themselves suggest, through their references to a legendary Bhauma-Naraka dynasty, that there could be a pre-5th century A.D. historical growth in the Brahmaputra valley. This inference can further be buttressed by the reference to this area in the Allahabad pillar inscription of Samudragupta of the fourth century A.D. and the miscellaneous references to Prāgjyotiṣa and the Lauhitya or the Brahmaputra in such texts as the Mahābhārata and the Arthaśāstra. On the other hand, there is no historical archaeological relic dating from the early centuries A.D. in Assam. It would also be quite unwarranted to infer that Periplus and Ptolemy's geography contain references to Assam. Their focus beyond the mouth of the Ganges was the Malayan peninsula, which was natural, considering the maritime character of Mediterranean contact with this part of the world. On the whole, it is difficult to argue that, even if the Assam-Burma-Yunan route was used in the late centuries B.C. and the early centuries A.D., it was significant in any way from the point of view of Assam and the Gangetic valley.

Clear historical light on this route is available for the first time in the seventh-eighth centuries A.D. when Hiuen-tsang and Jia Dan wrote their records. The detailed description of this route in its two branches in Jia Dan comes as a pleasant surprise after the sifting of ill-defined historical data. But can one really infer a regular caravan traffic along this route even in the seventh-eighth centuries A.D.? Occasional bands of monks and pilgrims did surely pass through but, as a careful perusal of Bagchi's enumeration of Chinese pilgrims to India and Indian Budhists who went to China (Bagchi 1951) shows, the monks and pilgrims were not thick on the ground along this line. There is also nothing to show a significant amount of commercial traffic. The archaeological level belonging to this period at Ambari does not show anything more than the use of kaolin clay and celadon ware. It is not known if these were imitated locally or meant direct Chinese import. By this period, however, there was contact with China also across the Tibetan plateau.

For an insight into the nature of routes and the mechanism of trade contact through them we have sifted some British records of the nineteenth century. There is, of course, a clear picture of routes in these records but the routes by themselves do not suggest significant contact and trade. These routes were not always used for regular commercial traffic, and although there was a certain amount of interchange of goods throughout this region, this was achieved through a system of inter-community barter.

It must at this point be reiterated that we are concerned only with the situation on the Indian side. We are not concerned with the Chinese trade coming down to Bhamo, which seems to have been reasonably organized. But even regarding this trade it was written in 1901 (Scott 1901) that the Bhamo route to China became unimportant as it was discovered that "the best trade route to China from Burma is the Thibaw-Thein-ni-Kung Long Ferry Road". It was also realized that the Bhamo route could never serve a large area of country. It was "certainly not the route by which to tap south-western China" (Scott 1901 : 64). This is in remarkable contrast to the unbounded enthusiasm to take British piece goods to south China through Bhamo in the middle of the nineteenth century (cf. Williams 1864).

The foregoing detailed historical examination of the Assam-Burma-China route has an important implication in Indian archaeological studies. Southeast Asia has often been visualized as a source of different cultural impulses in east India. The origins of agriculture and copper-bronze metallurgy are the most important areas of study in which these inferences have been made. As far as the archaeological material traits are concerned, the distribution of some southeast Asiatic types of neolithic artifacts has generated a good amount of discussion. Moreover, cord-marked pottery found in an undated context at Daojali Hading in the north Cachar hills has been taken to denote an early neolithic horizon with east Asiatic links. There is also a suggestion that the plain red pottery of Daojali Hading may be related to the Yang-Shao red pottery of the Huang Ho valley, which may be traced as far as Szechuan.

The force of many of these arguments has been broken by the evidence of a very early origin of rice cultivation in the Belan valley. Neolithic cord-marked pottery has also been found in this region. The point is that very little is known of the dates and the sequence of archaeological cultures in a large part of eastern India and the talk of southeast Asiatic parallels for some traits of these cultures has in general been nothing more than loose inferences. Our historical analysis of trade routes between Assam, north Burma and China possibly supports what F.J. Richards wrote in his classic paper, *geographical factors in Indian archaeology* :

> "The eastern frontier is...difficult ; true the Burmese and Shans have ravaged Assam ; and the Arakanese East Bengal ; but the flow of Indian influence is eastward penetrating Indo-China and the isles as far as Borneo. The meeting points of Chinese and Indian culture are in Turkestan and North Annam" (Richards 1933 : 235).

SUPPLEMENTARY NOTE

It should be useful to underline the following points which have emerged more or less recently, after this paper was written. First, an apparently neolithic culture dating from the second millennium B.C. has been reported from the Tibetan plateau (information from J.G. Shaffer), and this puts the reported stone harvesters from Sikkim in a different chronological light. However, as far as the issue of historical contacts is concerned there is no reason to change Bagchi's chronological analysis as mentioned in this paper. Secondly, in his presidential address (part II) to the 11th annual conference of the ISPQS, held in Gauhati in December 1984, T.C. Sharma (1984) has given an elaborate discussion on the recent advances in prehistory and archaeology of northeast India. There have been at least three major discoveries : the discovery of the Hoabinhian material in the Garo hills, Meghalaya ; the discovery of an apparently upper palaeolithic-neolithic lithic assemblage in the Khowai and Haroa valleys of western Tripura along with some stratified deposits of potsherds ranging from 3450±150 B.P. (1500±150 B.C.) to 1190±90 B.P. (760±90 A.D.) ; and the TL date of 1620 B.C. for the 4th layer of the excavated neolithic site of Napchik in Manipur (for the TL date, Singhvi *et al* 1983, for the site, Singh 1983). One of the present authors (DKC) could study along with K.V. Soundararajan the Hoabinhian material in Sharma's collection in Gauhati University. According to Soundararajan who is familiar with the Hoabinhian material in southeast Asia, there is no doubt about the identification of this material as Hoabinhian. This, in fact, puts the Assamese cultural growth in a most interesting light. The dates of the terraces in which the lithic material has been found in Tripura go back, according to the information given by S.N. Rajaguru, to c. 20000 B.P. The general assemblage of the seven-layered site of Napchik has an extensive range of corded and reddish-brown pottery along with tripod legs, flaked flat pebbles, ground tools, etc. These discoveries are no doubt significant but do not invalidate our analysis of the historical and archaeological significance of the northeastern frontier. As in the northwest (see Chakrabarti 1977), there was an interaction zone in this region as well, but here the contours of interaction were much less clearly defined and of no great historical significance from the point of view of Indian history.

Regarding the historical references mention may be made of the excellent chapters in the section on Assam in Ray 1980. It may also be noted that the Ambari radiocarbon dates come from the deposit above the subsoil water. There could be early historic material below the subsoil water level but one cannot be sure. R.D. Choudhury (1980) thinks that the votive stupas at Surya Pahar in Goalpara district may belong to the early centuries A.D. on stylistic considerations. Incidentally, Moti Chandra's assertion that "Assam in eastern India sent horses, jade and ivory handles" is, according to him (Moti Chandra 1977 : 67), based on the *Mbh* 2-47 and 12-14, but none of these references refers to Assam. In his recently published volume on the archaeology of central Brahmaputra valley R. Chaudhuri illustrates a surface collection of sherds from Dah Parvatiya. If one remembers correctly, there is a "Sunga" incurved bowl (c. 200 B.C.) which seems to be the first reported archaeological evidence of this period in Assam. Dah Parvatiya obviously needs excavation.

K.A.N. Sastry (the beginning of intercourse between India and China, *The Indian Historical Quarterly* 14(1938: 380-387) argues for a south Indian contact with China as early as the second century B.C. Two pieces of evidence have been cited by Sastry. The first of these is the suggested identification with Kanchipuram of a geographical term in a passage by Ts'ien Han Chou of Pan Ken who is said to have lived not later than than the first century A.D. The second piece of evidence relates to the find of a Chinese coin, probably of second century B.C., at Chandravalli in Mysore in 1909 A.D. by R.A. Narsimhachar. Taw Sein Ko to whom it was referred made the following observation : "there are four Chinese characters on the coin, of which three are very much blurred. The following dates have been suggested : 138 B.C., 502 A.D. and 886 A.D. The first appears to be most appropriate...Most probably Chinese merchants visited southern India during that period, and they came from Canton or some other southern port bringing with them Chinese brass coins of low value". Neither of these two pieces of evidence is convincing.

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ESR Dating of Kurnool Caves, South India

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INTRODUCTION

Electron Spin Resonance (ESR) dating is relatively a new method of absolute dating of archaeological bones and calcretes. Ikeya (1980) has demonstrated the applicability of ESR signals in estimating radiation doses received by archaeological bones and other materials bearing calcite. By the results he has obtained at Petralona cave (Greece), Ikeya has shown that samples as old as a couple of million years can be conveniently dated by the ESR method.

Adopting more less a similar procedure attempts are made, on an experimental basis, to subject a few samples for ESR dating from the Muchchatla Chintamanu Gavi II (MCG II), one of the Kurnool cave sites (15°25′ N : 78°8′E). Excavations here revealed three phases of occupation (Murty 1985). These, from the top to bottom, are : (1) Late Mesolithic displaying culture contacts with the Neolithic-Chalcolithic (0.20cm-1.20cm) (2) Mesolithic (1.20cm-1.35cm); and (3) Upper Palaeolithic (1.50cm-1.85cm and possibly extending below). (It should, however, be noted that the depth of these occupational phases varies in trenches depending upon the slope, and a clear-cut picture would emerge only after the completion of excavation.)

The Method

In this method, the archaeological dose of the natural radiation is evaluated by a procedure similar to that of Thermoluminescence (TL) dating. On burial in soils, the microcrystalline structures of stalagmites, kankars, bones etc. are affected by the continual bombardment of α, β and γ radiations from radioactive impurities present in soils. Similarly, the cosmic rays also bring about a change in the structures of these materials; the effect is predominant in open air and on materials close to the surface. The effect of the impinging radiations is production of defects in the form of trapped electrons. In calcite bearing materials, the trapped electrons are assumed to be in the form of $[CO_2^{-3}]$ species. There is thus, a steady accumulation of the defect centres over a time span. The concentration of these, naturally depends, firstly, on the duration of burial, and secondly, on the dose rate of the radioactive radiations.

The technique of electron spin resonance is used for estimating the total defects created in such materials; the intensity of ESR signals being proportional to their concentration. The archaeological dose estimation is done by additive dose technique. And the annual dose rate of the surrounding soil is measured either with dosimeters or from γ ray spectrometry.

Dating of Samples from MCG II Cave Site

The samples selected for ESR dating belong to five layers at MCG II. They are powdered and fractions

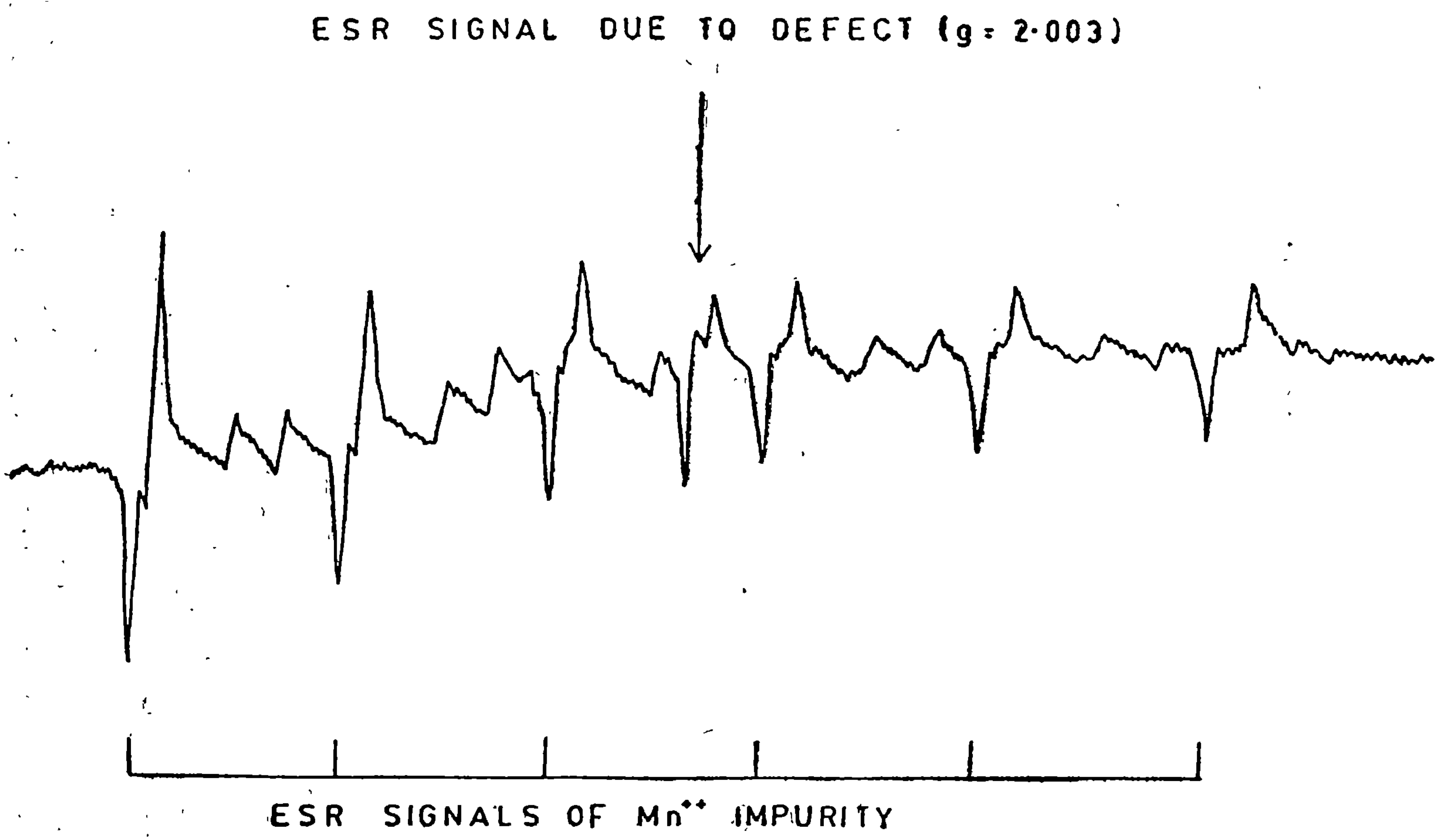

Fig. 1
Typical electron spin resonance signals of defects produced in bones and teeth from MCG II. The signal at *g*—2.003 is proportional to the archaeological dose.

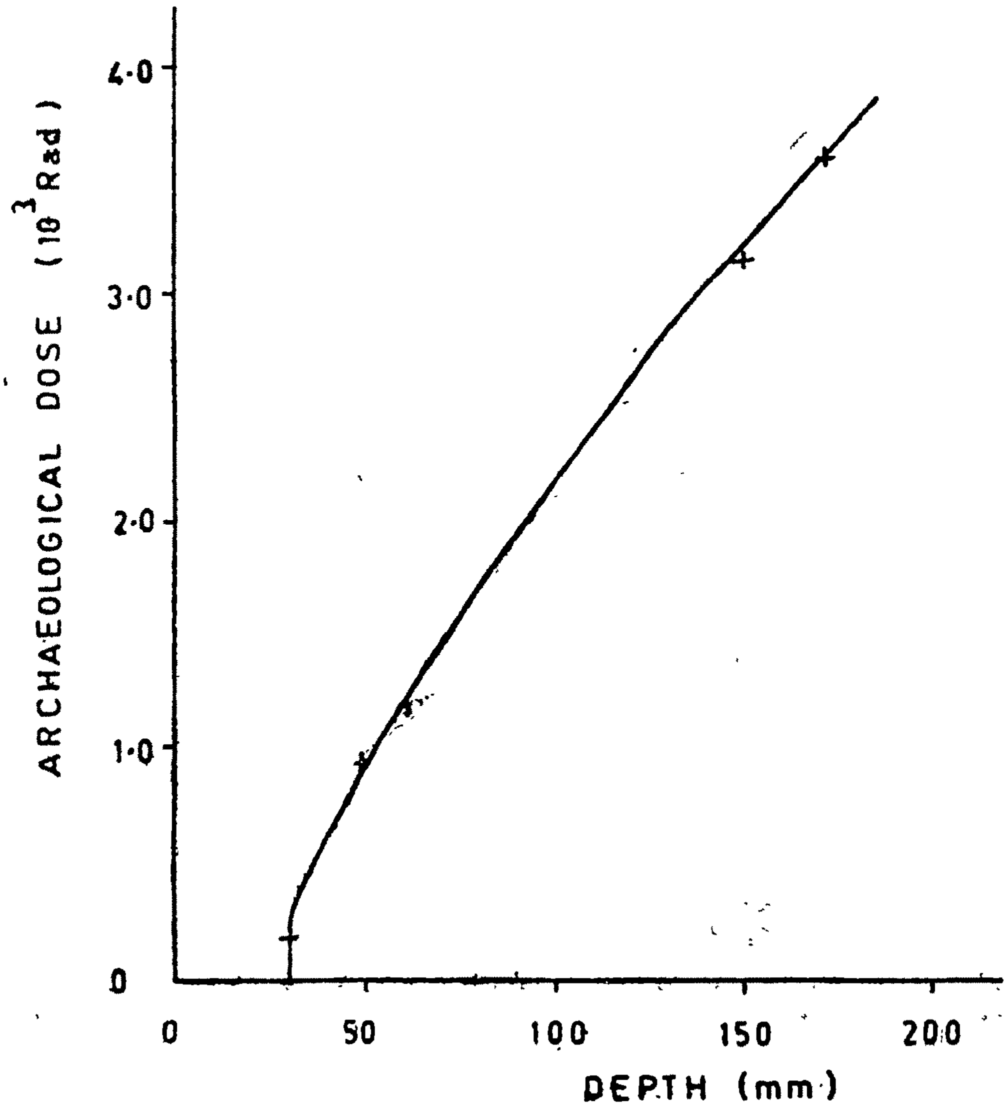

Fig. 2
Graph showing the variation in archaeological dose with depth.

between 60 to 150 are used for dating. Each sample is further subdivided into 4 to 5 parts for subjecting to different known γ doses. Gamma irradiation is made with a 60 Co radiation source (2.5 *K* rad/min) at the Advanced Centre for nuclear Chemistry, Poona University. The ESR measurements are carried out for signals at $g = 2.003$ (3400 gauss) in Varian (g GHз) spectrometer. Practically, all the samples contained Mn^{++} as an impurity. The impurity signals of Mn^{++} are used to calibrate the ESR signals (Fig. 1). ESR signals are found to increase with depth (Fig. 2), and this suggests that there is no post-depositional disturbance of the material. The signal intensity, when plotted against the known doses, showed linear increase (Fig. 3), following the equation :

$I = \alpha C_o + \alpha D$, where

I=Intensity of ESR signal,

D=Gamma dose in *K* rad,

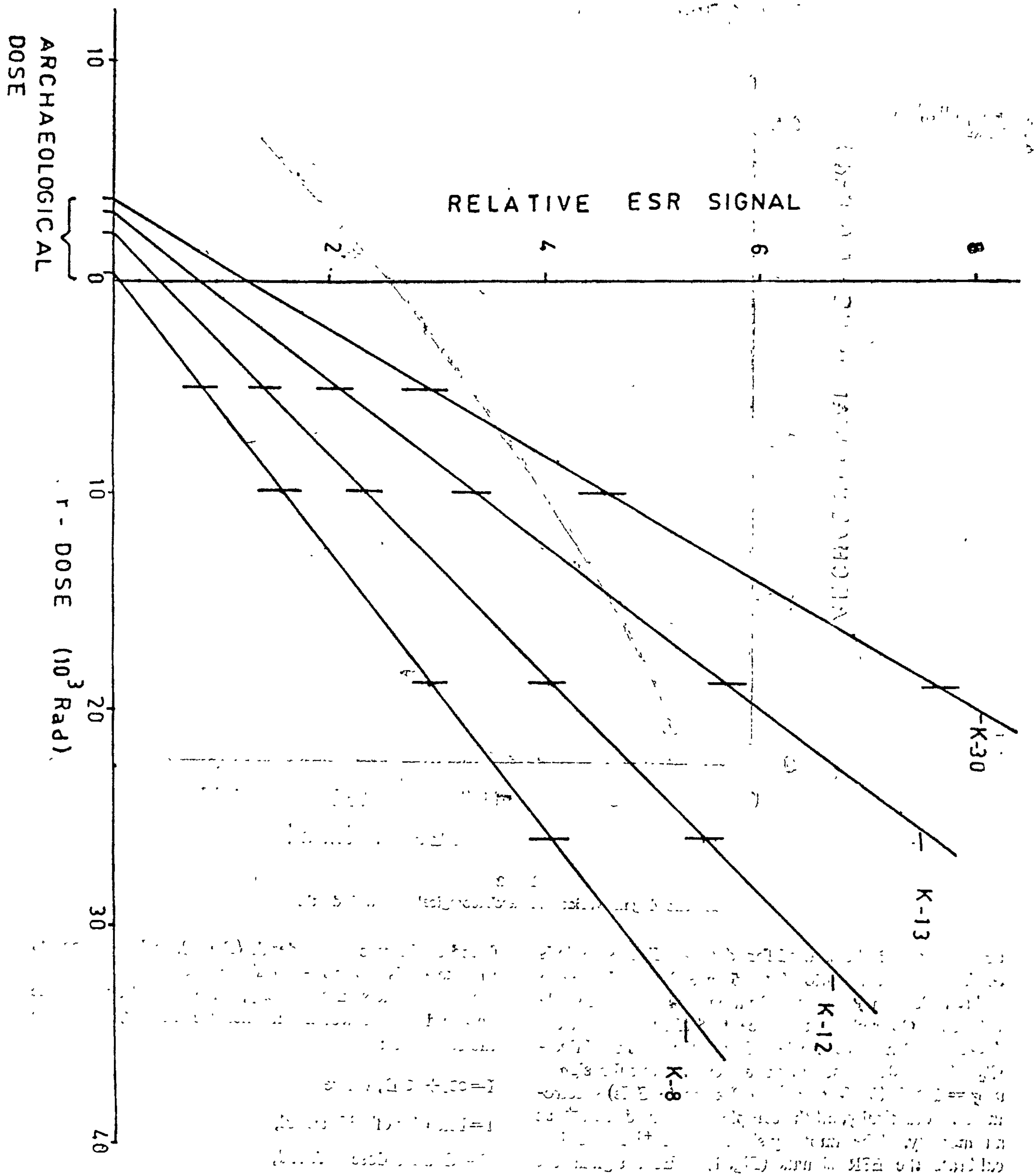

Fig. 3. Graph showing linear relationship of ESR signals and additive doses. The negative intercept gives the archaeological doses of the samples.

and α_0 and α, are the intercept and slope of the curve, respectively. These are determined by the method of least squares. The ratio α_0/α is equivalent to the archaeological dose.

The ESR dates obtained for the samples at MCG II are given in Table 1. In computing these dates, the annual dose rate (0.1871 rad/year) measured for a sample at MCG II in TL dating (Nambi and Murty 1983) is made use of. The error in ESR dates given here is likely to be in the range of 10% to 15%.

It may be pointed out at this juncture that these experiments on samples from MCG II indicate that bone materials are quite suitable for ESR dating, although the carbonate percentage is very low or almost nil. It is, therefore, evident that the defects were produced in the microcrystalline calcium hydroxy apatite which constitutes about 90% of the inorganic matter in bones. As against this, all the kankar samples (from MCG II) are found unsuitable for dating as the degree of crystallinity is low, although the total carbonate amounted to 70%.

Table 1

ESR Dates at Muchchatla Chintamanu Gavi II

Trench/Depth	*Sample*	*Archaeological Dose K rad*	*Age Years B.P.*
F 20 cm-40 cm	Bone	0.1673	893
F 40 cm-60 cm	Bone	0.9821	5247
B4 120 cm-135 cm	Tooth	1.7780	9498
B4 150 cm-165 cm	Tooth	3.1233	16686
F4 165 cm-180 cm	Bone	3.598	19224

DISCUSSION

These ESR dates are obtained from two trenches, Trench F and Treneh B. Trench F is laid in one of the cleft like passages in the limestone escarpment. The sediment in Trench F is a consolidated breccia and is associated with the remnant of a prehistoric box-type porcupine gravity trap. The dates for the two levels at Trench F : (1) 893 BP for F 20 cm-40 cm, and (2) 5247 BP for F 40 cm-60 cm (the porcupine trap belongs to this level) provide a time sequence for the upper levels of cave sediments. Trench B4, as mentioned earlier, is associated with a cultural sequence. The date 9498 BP for B4 120 cm-135 cm corroborates the archaeological age in that this level is associated with the Mesolithic phase. The dates of the two preceding levels, 16686 BP for B4 150 cm-165 cm and 19224 BP for B4 165 cm-180 cm corroborate the Upper Palaeolithic age of these two levels, as the culutral materials incorporated therein represent this phase. Moreover, the ESR date for E4 165 cm-180 cm is almost in agreement with the TL date of 17390 yr BP (Nambi and Murty, op. cit.) obtained for a burnt clay sediment from the same level.

As a word of caution, it is necessary to mention that ESR dating of bone and dental remains associated with archaeological materials is attempted, for the first time in the Indian context, on an experimental basis. Hence samples from different trenches and varying depths are subjected for investigation. The results, needless to say, are encouraging. It is proposed to date samples from regular columns in different trenches, and to refine the techniques of annual dose rate determination by γ ray spectrometry, and the calculation of error.

ACKNOWLEDGEMENTS

The Kurnool caves are being excavated as a part of a research project of the second author funded by the U.G.C. Thanks are due to this body. Thanks are also due to the Advanced Centre for Nuclear Chemistry, University of Poona, for extending all help and facilities.

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NOTES & NEWS

Acheulian Elements from Hosiarpur Region (Punjab)

The area of investigation lies between the villages of Atvarpur (30°14′ N and 75°54′ E) and Takhani (31°39′ and 75°55′ E) and falls in the jurisdiction of Hoshiarpur district of Punjab state. This area is drained by a number of *chos* (hill torrents) of which Doonge Tote Wali cho and Bari cho are important and has yielded stone tools along with other chos viz., Rehmanpur cho and Takhani cho which has also yielded stone implements.

Geology

The conglomerate and the sand rocks are the main formation in this region. The conglomerate is not cohesive and contains mainly pebbles, boulders and cobbles of quarzite. Stray cobbles of granite, limestone, sandstone and lumps of claystones are also present. The matrix, when present, consists of medium to coarse grains and at places of calcarıous cement which imparts certain degree of hardnees to the otherwise loose conglomerate beds. They vary in thickness from 15 cms to 2.50 m. Sandstones are poorly lithfied and consequently are soft and bariable. They are pale grey to brownish grey in colour and contain a large proportion of mica flakes and concretion of clay. They are prone to easy weathering and their considerable collection of sand as talus cone of the recent deposits and these gravel beds constitute an important source of quartzite fragments (GSI 125 year's anniversary celebration souvenir).

The area under the present study was taken up for explorations bccause so far the prehistorians in the region had been exploring the valleys and duns while the area of Shivalik frontal ranges were neglected even by those who considered that there were undoubtedly Acheulian elements in this region (Mohaptra, 1980). The exploration work in this region was taken up in 1977 for the Department of Archaeology, Punjab in the area around Dholbaha. Chopper-chopping tools were collected from Baba Pir, Narod, Phaphyali, Dholbaha, Janauri and Dandoh. Exploration further south east struck Acheulian and Soanian elements together at Atvarpur, Rehmanpur and Takhani. The extension of Acheulian elements does not go beyond this area as is evident from the explorations. Atvarpur was the epicentre of this culture from where a large number of artifacts were collected. The discovery of a number of acheulian sites have controverted the view of the prehistorians that only chopper-chopping tools predominated in this area. Mohapatra has also agreed to this that some Acheulian elements are there in this region which is otherwise dominated by the Soanian elements.

Lithic Industry

The total number of specimens collected from the three sites (Atvarpur, Rehmanpur and Takhani) is 110. These tcols were found from the beds of the Doonge Tote Wali choe, Bari choe, Rehman choe and Takhani choe. All the tools in the collection are made of fine to medium grained quartzite of yellow, brown reddish and blue colours.

At Atvarpur the tools were collected from choe beds of the first two choes and are numbering 83. Out of these are 9 hand axes (10.84%), 16 cleavers (19.27%), 31 flakes (37%), 8 unifacial choppers (9.94%), 16 bifacial choppers (19.28%) and 3 cores (3.61%).

At Rehmanpur the choe bed of Rehmanpur choe yielded 9 stone tools out of which flakes are 4 (44.44%), hand axe 1 (11.11%), bifacial choppers 2 (22.22%), and 2 cores (22.22%).

Out of the 18 specimens from Takhani, found from the Takhani choe, cleavers are 24 (22.22%), bifacial choppers 2 (11.11%) unifacial chopper 1 (5.56%) burin 1 (5.56%) and flakes 10 (55.56%)

The following stratigraphy was observed at Doonge Tote Wali choe from where the maximum number of tools were found.

10-15 cms	surface humus
1.00 m	Sand and Clay
15-25 cms	Gravel deposit 11
1.25 m	sand and clay
15-25 cms	gravel deposit 1
10-15 cms	sand and clay
	Bed

Two tools were found embedded in the gravel deposit 11 about 1.60 m from the choe bed.

The collection from these three sites amply prove that both the Acheulian and Soanian elements occur together in the same context. Out of the total collection of 110 artifacts Hand axe and Cleavers constitute 27.27% Chopper-chopping tools 26.36%, flakes and flake tools 40.90% and cores 5.45%.

Among the tools found from the sites are the cheulian horse-shoe shaped and right-angled pointed cleaver, ovate and laneolate hand axes, core choppers with prepared platform, piercer-cum-scraper and burin. These elements indicate more advanced features than the Chauntra industry of the North Western region The tools are slightly rolled and without any patination. A number of tools show the use of the cylindrical technique. Multidimensional flaking is characteristic of the hand axes and cleavers which resemble the Madras hand axe industry. Step flaking in the case of hand axes, double vaal and victoria west III technique in case of cleavers have been used extensively and some of them have 'S' twisted profiles. On the basis of these techniques used for preparing the tools these artifacts can be placed in the mid to late Acheulian state. The tools can be compared with the European and African Coup-de-poing industry. One broad end Hand axe with thick pronounced butt end and narrowing body ending in a narrow cleaver like straight edge, technically ascribed to this group, can be placed in the transitional stage between hand axe and cleaver.

The pebble tools from one of the sites viz., Atvarpur, belong to the chopper chopping series and are comparable to those of Sirsa valley near Nalagarh, Soan valley near Daulatpur and the Beas-Banganga valley in Kangra.

The flake tools have been prepared by the Clactonian and Levalloisian techniques. Clacton like flakes predominate with a wide angled unfaceted striking platform. Mostly primary flaking has been used with minimum secondary flaking and retouch. Scrapers of various types are fabricated on these flakes.

The industry, which is a mixture of pebble-core-flake artifacts, cannot be dated precisely because of the lack of ths geomorphological and palaeontological evidences and secondly the landscape of the Atvarpur, in general is of the rewashed and redeposited type.

Owing to the paucity of material available to Mohapatra from this area he concluded that Soanian and Acheulian are separate cultures as Atvarpur is an exclusively Acheulian site. In a hurried trip during when he took Prof. Ranov to this area he could not come across any Soanian elements and declared this area as exclusively Acheulian. On this basis he concluded that Soanian and Acheulian are heterogenous cultures. But since these cultures are now found in the same area and in the same context (overlapping) the authors are of the view that the Acheulian and Soanian were homogenous group and had a common origin. It seems that during the evolutionary phase both types of tools were in use simultaneously Our findings tend to support the conclusions of Graziosi that the Soanian and Acheulian have a common origin.

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The Lithic Industries of the Santal Parganas with Notes on the Damin Industry

INTRODUCTION

This is a brief report on an archaeological reconnaissance of the Santal Parganas (23°40′—25°18′ N and 86°28′—87°57′ E ; over 5470 square miles) on behalf of the archaeology-museum unit of the Department of History, Delhi University, in January 1985. This former Bihar district has been subdivided into four separate districts—Dumka, Deoghar, Godda and Sahibganj.

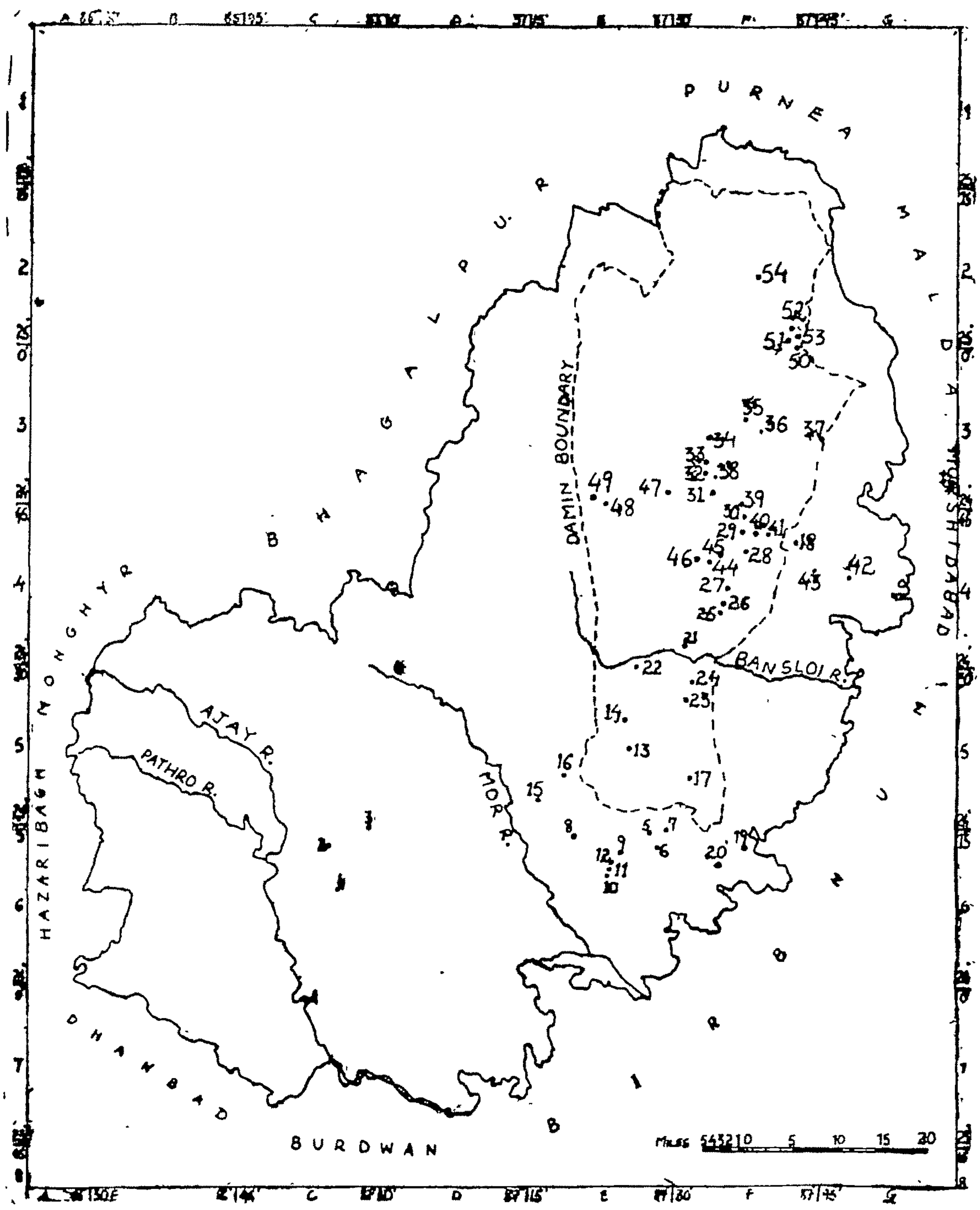
It has three clear physiographic components. The west or southwest section is dominated by a rolling topography interspersed with hills. The Calcutta-Patna section of the Eastern Railways cuts through this area. Communication-wise this section was not important till the advent of the railways. The most important river in this section is the Ajay which, like the lesser rivers of the region, has a shallow bed and frequent meanders. In the Godda area and the stretch between Barharwa and Teliagarhi along the Ganges the topography is flat and alluvial. The Barharwa-Teliagarhi stretch is historically the most important communication line between the middle Gangetic valley and the regions further east. This is a corridor defined by the Rajmahal Hills on the west and the Ganges on the east. The hills come very close to the river-bank in places (cf. Maharajpur) and offer scope for defensive positions (cf. ruins of mediaeval forts at Teliagarhi north of Sahibganj and Sakrigali south of Sahibganj). The rim of the hills overlooking the river is now honeycombed with stone quarries and we like to imagine that the situation was the same in antiquity, particularly during the Pala and Sena periods when the stone from the Rajmahal Hills was widely used to make innumerable stone sculptures. The hills peter out beyond Teliagarhi, although an outlier provides a distant backdrop to the ruins of the *Vikramsila* monastery.

The core of the district is formed by the main spread of the Rajmahal Hills and named Damin-i-Koh or "the skirt of the hills". This name was coined in the early days of the British penetration in the area and is possibly used even now in its revenue administration. The Rajmahal Hills which are aligned roughly from northeast to southwest with a general elevation of 1000-2000 ft. enclose in their hillsides, valleys, ravines and plateaus a world distinctive enough to be called by a separate name. The rim of the encircling hills is always sharply defined and offers at various points sceneries of an impressive contrast between the hills and the plain (cf. the outline of the massif as seen from the level stretch of the Rampurhat—Shikaripara road, the view of the plain near Barharwa from the hills, the first glimpse of the plain on the Banjhi—Sahibganj road, the Murshidabad plain as seen from the eastern outskirts of Pakur, etc.). The most important inner valley is the valley of Barhait which occupies a more or less central position in the configuration of the ranges. The hill tops and slopes are generally marked by the Paharia villages which are associated with extensive *jhum* cultivation of *Sabai* grass, sorghum, beans, etc. The valley bottoms are occupied by the Santals who, although immigrants to the area since the 18th-19th centuries, have given their name to the district. It is the Paharias who are the autochthones of the Rajmahal Hills. The hill produce comes down to the weekly markets, the most important of which seems to be the weekly cattle market at Hiranpur at the fringe of Damin. The hill-top world of the Paharias (some scholars argue for their mention in Megasthenes, although we consider this improbable) has been thrown open. The sight of elderly moneylenders riding slowly toward the hills is a common enough sight in Damin.

A number of rivers originate in the Rajmahal Hills—the Bansloi, Brahmani and a few minor tributaries of the Mor or Mayurakshi which itself originates near Deoghar in the western section of the district.

The Inventory of Sites and Artefacts

Apart from F.R. Allchin's analysis of the Bodding collection of neolithic tools from Mahulpahari region in the southern Rajmahal Hills (now in the Oslo museum), sporadic reports of "middle palaeolithic" tools by the officers of the Bihar archaeology-museum directorate and the mention of a few Gupta sculptures in Sahibganj, the archaeology of the Santal Parganas has been totally unknown. No historical light falls in


PURNEA
MALDA
MURSHIDABAD
BHAGALPUR
MONGHYR
HAZARIBAGH
DHANBAD
BURDWAN
BIRBHUM
AJAY R.
PATHRO R.
MOR R.
BANSLOI R.
DAMIN BOUNDARY
MILES 5 4 3 2 1 0 5 10 15 20

Sites Mentioned in the text

this region except the fact that the modern Suri—Massanjore-Dumka-Bhagalpur road could have been the route through which Rajnagar, the Pathan capital in the adjacent Bengal district of Birbhum, maintained its links with the Bhagalpur area.

Our "site and artefact inventory" has been arranged according to their occurrence in the non-Damin and Damin areas. *What we in this context have called the Damin industry is, according to us, an upper palaeolithic industry with microlithic elements, which occurs in a well-defined stratigraphic situation and is marked by the almost exclusive use of a patinated brownish cherty material as raw material.*

1. The Ajay Bridge (AYB): on the Jamtara-Dumka road-microliths occurring in the upper part of the reddish, sandy silt or clay deposit—parallel-sided blades (5), flakes (6), lunate (1)—total 12—mostly quartz but the lunate is in a blackish cherty material.

2. Noadih (NDH) : 11 km from Sarath on the Sarath-Palajori road—the place, a broken patch of land, is at the foot of a hill—the microlithic specimens (total 6) occur in the gullies cores (2), flakes (2).

3. Fuljori (FJR) : about 8 km from Palajori on the Sarath—Palajori road—a huge amphitheatre formed by the hills at this point—microliths (total 3)—flakes (2), core (1)—occur in the eroded gullies.

(4) Hartopa (HRT) : 18 km from Palajori towards Jamtara—2 lower palaeolithic scrapers and 2 microlithic specimens (flake-1, scraper-1).

5. Shikaripara-I (SKP) or Chaipani (CHP): not far from the Shikaripara Inspection Bungalow—2 lower palaeolithic specimens (flake-1, retouched flake-1, retouched cores-2).

6. Shikaripara II (Hills) : this is the hilly and jungly area south and southeast of Shikaripara—microlithic specimens (total 2; 1 retouched flake, 1 waste flake) occured in the slope debris.

7. Shikaripara III or Kolpara (KLP) : a few km away from Shikaripara, close to the village of Jabardaha, a village of *dhokra* craftsmen—2 lower palaeolithic specimens (handaxes) in the eroded gullies.

8. Karma (KRM) : 9 km from Dumka on the Dumka Shikaripara road—4 microlithic specimens (3 flakes, 1 retouched flake).

9. Mahulpahari (MHL) : 1 quartz handaxe in the eroded land behind the Missionary hospital area.

10. Ganrapur (GNP) : 2 km from Chiruadi towards Pattabari—3 microlithic specimens (3 scrapers) in the eroded land of the area.

11. Chiruadi (CHR) : 1 km from Indrabani towards Pattabari—1 lower palaeolithic scraper and 5 microlithic specimens (1 retouched flake, 4 waste flakes) in the eroded gullies along a stream.

12. Indrabani (IDB) ; 14 km from Massanjore—Pattabari road—7 microlithic specimens (flakes—4, P.S. blades—2, point—1) in the generally eroded hill slope.

13. Kathikund (KTK) : 7 microlithic specimens in the eroded land along a stream at the entrance of Kathikund from Dumka (scraper-cum-point 1, waste flake 1, cores—2. P.S. blades—3).

14. Narganj (NGJ) : a few km from Kathikund towards Silingi—a patch of bad lands beyond the local stream—3 microlithic specimens (core 1, flakes 2).

15. Kuka (KKA) : 4 km from Dumka on the Dumka-Kathikund road—eroded gravelly land—15 microlithic specimens (flake-3, P.S. blades—4, scraper—2, burin—1, lunates—2, backed blade-1, obliquely blunted blades—2).

16. Burkunda (BKD) : 14 km from Dumka on the Dumka-Kathikund road—large patch of eroded gravelly land along a stream—6 microlithic specimens (cores—2, flake-1, P.S. blade—1, retouched flake—1, cleaver—1).

17. Hiranpur (HNP) : a wide expanse of gravelly hillocks near the missionary hospital—11 microlithic specimens (cores—2, flakes—4, P.S. blade—1, scrapers—3, point—1).

18. Saldaha (SDH): a river crossing before approaching the village from the Shikaripara side—hill slopes in the vicinity—2 microlithic flakes.

DAMIN

19. Kendpahari (KND) : 17 km from Rampurhat on the Rampurhat-Dumka road—an extensive rocky outcrop—tools either embedded in or on the surface of the top soil—this is the site where the Damin industry was first identified—core (17), blade core (1), retouched core (7), flake (3), retouched flake (4). scraper (2), double-sided scraper (1), scraper-cum-borer (1), blade fragment—1,—total 37 specimens.

20. Ban Haripur (BHP) : more than a km away from Kendpahari—core (2), blade core (1), blade (1), flake (2), scraper (3)—total 9.

21. Pachaura (PCH): towards Alubera from Amrapara, not far from the Bansloi—extensive spread—about 1 m thick top soil on bedrock—tools embedded, also on the surface and the exposed sections—cores (15), flakes (4), retouched cores (28),

retouched flakes (36), scrapers (95), scraper-cum-borers (5), notched scraper (1), round scraper (1)—total 225.

22. Silingi (SLN) : by the side of the jungle road towards Silingi from Durgapur—embedded in the top soil—cores (3), flakes (8), retouched core (1), retouched flake (1), scraper (1), round scraper (1)—total 15.

23. Chhattarchua (CTC) : 11 km from Amrapara on the Amrapara —Dumka road—DAMIN : flake (1), retouched flake (1), retouched blades (2), scrapers (5), scraper-on-blade (1). scraper-cum-borer (1)—MICROLITHIC ELEMENT : retouched cores (2), retouched flake (1), P.S. blades (2), end scraper (1).

24 Ranga (RNG) : 7 km from Amrapara on the Amrapara—Dumka road—DAMIN : blade cores (2), retouched core (1)—MICROLITHIC : end-scraper (1), scraper (1).

25. Salchhatra (SCH) : 8.5 km from Amrapara towards Litipara—retouched flakes (6), retouched core (1), scraper (5), scraper-cum-borer (2), scraper-cum-point (1)—Total 15.

26. Kamardiha (KMD) : 2 km from Salchhatra towards Litipara—core (1), flake (1)—total 2.

27. Soharchati (SHC) : 9.5 km from Litipara towards Amrapara—DAMIN : flake (1), retouched flake (1), retouched blade (1), scraper (3), scraper-cum-borer (1)—MICROLITHIC : fluted core (1), retouched flakes (2), retouched core (1), borer (1).

28. Litipara Damin Bungalow (LDB) : flake (1), retouched flakes (2), retouched core (1), borer (2)—total 6.

29. Saola (SLA): about 2 km from Litipara Damin Bungalow—left of the road—a small stream—extensive spread mixed with the top soil cover—section available at a point along the stream —top soil underlain by bedrock—handaxe (1), scraper-cum-borers (3), round scraper (1), burins (2)—total 7.

30. Rampur (RMP) : 4 km from Litipara towards Barhait—DAMIN : retouched core (1), blade (1), retouched blade (1), scrapers (3)—MICROLITHIC : retouched flake (1), retouched core (1), end scraper (1).

31. Dharampur-Kadoya (DMP) : 13 km from Litipara towards Barhait—retouched flakes (4), scraper (1), scraper-cum-borer (1)—total 6.

32. Hatibathan (HBT) : 15 km from Litipara towards Barhait—stream section available—top soil underlain by bedrock—DAMIN : retouched cores (2), retouched flakes (2), retouched blades (3), scrapers (5)—MICROLITHIC : core (1), flake (1), scraper (1).

33. Paderbathan (PDB) : 17 km from Litipara towards Barhait—DAMIN : core (1), retouched cores (3), retouched flakes (2), scrapers (9), borer (1)—MICROLITHIC : fluted core (1), retouched flake (1), scraper, P.S. blade (1).

34. Barakadma (BKD) : 22 km from Litipara towards Barhait—total 8 (flake—1, retouched flake—1, scraper-1, blades—4, end-scraper—1).

35. Daldali (DDL) : 1.5 km from Barhait towards Barharwa—DAMIN : flake (1), retouched cores (2), retouched flake (1), scrapers (4)—MICROLITHIC : flake (1), scraper (1).

36. Kargu (Jamri Pahar, KJP) : 6.5 km from Barhait towards Barharwa—DAMIN : retouched flake (1), scrapers (4)—MICROLITHIC ; retouched core (1), scraper (1).

37 Muditola (MDT) : 5.5 km to Barharwa—the last line of the hills—flake (1), retouched flake (1), retouched cores (2), discoid scraper (1), notched scraper (1). Total 6

38. Sonadhani (SND) : 20 km from Barhait towards Litipara—DAMIN : cores (2), retouched cores (2), retouched flakes (8), retouched blades (5), scrapers (3), end-scraper (1), scraper-cum-borer (1)—MICROLITHIC—retouched flake (1), retouched core (1), retouched blade (1), scrapers (2).

39. Daharpur (DHP) : 9 km from Barhait towards Litipara—retouched cores (2), retouched flake (1), scraper (1). Total 4.

40. Jerlipur (JLP) : 3 km from Litipara towards Hiranpur—a stream section showing implementiferous top soil above bed rock—retouched flakes (4), hollow scraper (1)—Total 5.

41. Jenagaria (JNG) : 5 km from Hiranpur towards Litipara—DAMIN : retouched flakes (2), retouched cores (2), scraper (1)—MICROLITHIC : borer (1), point (1), end scraper (1).

42. Sonajuri (SNJ) : outskirts of Pakur, roughly 6 km from its station area—rocky uplands—plenty of raw material—DAMIN: cores (3), retouched core (1), blades (2), scrapers (9, 3 on blade), scraper—cum-borer (1), scraper-cum-point (1), end scraper (1), side-cum-end scrapers (3)—MICROLITHIC : blade core (1), P S. blades (3), end scraper (1).

43. Ranga (II)—RNG—between Pakur and Litipara—raw material extruding on the surface—DAMIN : flake (1), retouched flakes (3), retouched core (1), scrapers (3), end scraper (1), burin-on-core (1)—MICROLITHIC : fluted core (1), flakes (2), retouched flakes (3), scrapers (2), notched scraper (1), borer (1).

44. Marro-Dumurchi (MRD) : on the way to Singarsi from "zero point"—core (1), flake (1).

45. Kerokundi (KRK)—a hill valley—on the way to Kachna Surajbera from the Singarsi area—core (1), retouched flakes (2).

46. Amirjola (AMJ)—near Amrapara—core (1), flakes (2), retouched flakes (2), retouched blades (2), blade (1), scraper-cum-points (3), scraper (1)—total 11.

47. Salpara (SLP): on the way to Godda, within the Damin boundary—DAMIN: flakes (3), retouched flake (1), scraper (1), scraper-cum-borer (1), scraper-cum-point (1)—MICROLITHIC: flakes (6).

48. Rampur (RMP)—on the way to Godda, within the Damin—cores (3), retouched core (1), flakes (2), retouched flakes (2), borer (1), scraper (1), notched scraper cum point (1), burin-on-core (1), total 12.

49. Dhanjora (DNJ): on the way to Godda, within the Damin—DAMIN: core (1), flake (1), retouched flake (1), retouched blade (1)—MICROLITHIC : fluted cores (2).

50. Sitapahar (STP)—10 km from Tinpahar—retouched flakes (4).

51. Murtipahar (MTP) : 3.5 km from Tinpahar—flakes (2), scrapers (2), borer (1).

52. Madansahi (MDN) : on the Tinpahar—Borio section—flakes (2), retouched flake (1).

53 Yashkuthi (YSK): 5 km from Tinpahar—DAMIN: cores (3), flakes (11), noched scraper (1)—MICROLITHIC : cores (2), flakes (5), rotouched flake (1), scrapers (2), end scraper (1), notched scraper cum borer (1), blade (1).

54. Banjhi (BNJ): on the Borio—Sahibganj stretch—flakes (7), retouched flakes (4), retouched blades (2), scraper (1), end scraper (1).

DISCUSSION

Is the aforesaid division of the lithic industries of the Santal Parganas into the non-Damin and Damin industries correct ? In view of the general distribution of the Damin industry in the Damin area and also because of the homogeneity and distinctiveness of the Damin industry we do not have any doubt that it is a correct and logical divison. The only occurrence of the Damin industry in the area which is strictly speaking "non-Damin" is at the contiguous sites of Kendpahari and Haripur, but at the same time it may be noted that both these sites occur only a little outside the Rajmahal Hills massif near Shikaripara. Moreover, the occurrence at Kendpahari where this industry was first found is around a rocky outcrop.

The homogeneous character of the industry is more than apparent in its choice of raw material—a brownish cherty substance which is now generally patinated and imparts a kind of glossy look to the artefacts. It is not that there is no other suitable raw material available in the Rajmahal Hills but it is only this material which was preferred by the makers of this industry. Again, the homogeneity and distinctiveness of this industry are forcefully brought out by its artefactual assemblage. The break-up of the individual components in the total assemblage of roughly 545 specimens collected from 36 (nos 19-54) Damin sites is as follows :

flakes—55, cores—54, blade cores—4, retouched cores—58, retouched flakes—98, scrapers of different varieties including scraper-cum-borer, scraper-cum-point, notched scraper, end scraper, etc.—244, blades and retouched blades—22, handaxe—1, borers—5, burins—4.

It is obvious that the retouched flakes, cores and scrapers constitute more than 70% of the total collection, with the scraper as a general type being overwhelmingly dominant. This industry is without doubt a new one in east India.

The Context of Occurrence

The basic stratigraphic context of the occurrence of this industry has been clear at four sites. First, at Pachaura (site no. 21), on the way to Alubera from Amrapara, there is about 1 m thick soil deposit underlain by bedrock. In the exposed gully sections the artefacts were clearly seen coming out of this soil. Our observation showed that the microlithic artefacts also belonged to the same level in this soil profile. Secondly, at Saola (site 29) near Litipara towards Barhait the section along a stream cliff showed the position of the artefact-bearing top soil immediately above bedrock. Thirdly, at Hatibathan (site 32), about 15 km from Litipara on the Litipara-Barhait road a stream section revealed the same position of the top soil. Fourthly, at Jerlipur, (site 40) about 3 km from Litipara towards Hiranpur, exactly the same position is indicated by a stream section. It is expected that a more careful and intensive study of this top soil in various areas will yield extremely important informations. This will also bear excavations at various points.

The Mode of Occurrence

As far as we have been able to ascertain, the mode of occurrence of this industry covers the following primary situations :

(1) on the undulating stretches of plain land sloping down to a stream—Saola offers a very convenient example of this type.

(2) the edge or inside of the present day forests—the Kerokundi valley on the way to Kachna Surajbera is a typical example.

(3) the areas with extensive strensive stretches of raw material—Sonajuri near Pakur is a good example of this kind.

The Size of the Occurrences

In almost all cases the spread is impressive. Saola, Pachaura, Kendpahari, Ban Haripur, etc. clearly indicate that the distribution of artefacts in a given area could surely encompass areas running into a few acres. On the other hand there could be small patches as well, although our impression in these cases is that we did not look around hard enough. A careful study of the size of these occurrences should be part of any future work in the area. On the whole we have been impressed by the abundance of sites and artefacts of the Damin industry. Our impression is that a much larger number of sites could easily have been identified if only we could spend a little more time in the field.

The Associated Microlithic Element

That there is a microlithic association with this industry is suggested not merely by our close observation of the surface scatters but also by the apparent occurrence of microliths in the same material with specimens of the Damin industry in the Pachaura gully sections. Microlithic specimens occur at 15 of our 36 Damin sites. The microlithic types include some fluted cores as well. The association between the Damin industry and the microlithic elements will need careful investigation in future.

At this point it may be worth recording that in the wake of our reconnaissance in the Rajmahal Hills, a student of ours--Shri Nalini Kanta Thakur of Dumka—undertook a detailed survey of the area between Amrapara and Silingi. According to him his discoveries include purely microlithic sites on hill slopes of the area. It is perfectly possible that there is also a separate microlithic horizon in the area, which our limited work has not been able to isolate. In that case, if our experience in some West Bengal areas is any indication, these microlithic scatters on the hill slopes may contain some neolithic celts as well.

The Status of this Industry

We would firmly call it "upper palaeolithic". First, its occurrence in the soil cover over the bedrock in the area clearly suggests considerable antiquity. Secondly, there is an incipient blade industry. Thirdly, its overwhelmingly dominant scraper element may suggest a middle palaeolithic affiliation, but the very presence of microlithic elements in the assemblage immediately argues for an upper palaeolithic status. M.L.K. Murty also came to the same conclusion after briefly studying this material. As he puts it in a letter to the present author : "I am of the opinion that these occurrences are amorphous, typical of industries in the woodland ecosystems ; and my hunch is that they may represent a regional facies of the Upper Palaeolithic. We have similar occurrences (amorphous) in woodland ecotones especially in Adilabad district."

Observations on the Non-Damin Occurrences

They are very limited in character and more in the nature of mere sporadic occurrences than anything else. The lower palaeolithic implements come indisputably out of lateritic gravels and thus are similar in stratigraphic situation to the palaeolithic occurrences in large tracts of West Bengal and Singhbhum. The microlithic specimens are apparently from the surface of the gravels.

SUMMARY

Although the present reconnaissance in the Santal Parganas has failed to throw any light on the neolithic industry of the region, as suggested by Allchin's analysis of the Bodding collection in the Oslo museum, it has succeeded in discovering sporadic occurrences of lower palaeolithic and microlithic tools in the rolling topography of the western section of the district and isolating a widespread occurrence of an upper palaeolithic industry in its Damin or the Rajmahal Hills area. Embedded in the soil cover over the bedrock in this region and made uniformly of a brown chert marerial this industry is characterized by an overwhelmingly dominant element of scrapers of various kinds, retouched flakes and cores and also by an incipient blade industry along with microliths including fluted cores. This microlithic element could have led to a separate microlithic horizon (with some amount of neolithic tools, if some West Bengal data are any guide) in the area (possibly hill slopes). Whatever may be the ultimate verdict on the Stone Age situation in the Santal Parganas, there cannot be any doubt that the Damin industry which we have identified in the Rajmahal Hills is an upper palaeolithic industry with a strong regional character and that this could have led to the development of a separate microlithic horizon with some neolithic tools in the region. The Paharias of this region still maintain an identity of their own, and when one remembers that these Paharias are the real autochthones of the area, one realizes the tremendous potential of ethno-archaeological investigations in the Rajmahal Hills. This impression is further supported by the feeling that the Damin encloses a reasonably secluded world. In fact, our own field assessment is that the Rajmahal Hills look inward and possibly never had more than a marginal interaction with the Gangetic plains over which these hills stand like sentinels in the stretch between Teliagarhi and Barharwa.

ACKNOWLEDGEMENT

I was assisted in the field by Shri R.K. Chattopadhyay of the archaeology-museum unit of the Department of History, Delhi University. My grateful thanks are due to him. Shri Arjun Singh of the office of the Executive Engineer, Jamtara, Shri J.L. Agrawal, the District Engineer, Dumka, Shri S.L. Gagrai, Circle Officer, Litipara and Shri Thakur, Circle Officer, Taljhari, were very considerate to us. Ms. Kalpana Krishan has kindly drawn the accompanying map of the Santal Parganas showing the site locations.

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Book-Review

The People of South Asia (The Biological Anthropology of India, Pakistan and Nepal) by J.R. Lukacs Pages 465, Plenum Press, New York and London, 1984, Price not mentioned

This elegantly brought out and well documented volume deals with the biological anthropology of the living and prehistoric South Asians. Lukacs has tried to bring together palaeoanthropologists, archaeologists, human biologists and geneticists towards a common goal. It is good to see Western and Indian authors joining hands in this venture. A reference compendium of prehistoric human skeletal remains and burial practices enhances the value of the book.

The volume has been organised in two parts. Part-I deals with Palaeoanthropology and part-II with the Biological Anthropology of the living. Naturally, the volume begins with the Miocene Hominoids by Badgley et al. The Hominoids of South Asia are bracketed within 16-7 My. It appears that they flourished in a forest—woodland ecology and became extinct perhaps due to the changes caused by the Himalayan orogeny. The next article by Kennedy on the Mesolithic South Asians is a big jump in time from the Miocene to the Holocene. Luckily, now we have some skeletal material for the Hominids also both from the Narmada valley and the Shiwaliks and I am sure the new edition will have an article on the Hominids too. Kennedy emphasises on the evolution of area specific features as a result of widespread selective pressures to explain the phenotypic pattern of the Gangetic Mesolithic people and does not support any theory of migration. The realisation of full ontogenic growth and low incidence of disease has been shown as an example of an extremely successful adaptation of the Mesolithic people of Sarai Nahar Rai and Mahadaha. Dutta discusses the biological anthropology of the Harappans and brings out an affinity of the Harappans with the people of Tepe Hissar and Sakkara. This curious conclusion needs to be critically examined before drawing wider conclusions. Jim Shaffer strikes a different note and pleads for a critical evaluation of linguistic data to be able to believe the theory of Aryan migrations. Sankalia et al describe archaeological and palaeodemographic data from Inamgaon. Lukacs discusses the dental anthropology of some Neolithic and Chalcolithic sites of India. He points out the Mesolithic affinity of large tooth size populations and shows a reduction of tooth size in the Chalcolithic skeletons. This reminds one of the Harappan teeth which are so small in size (microdonty) that they indicate a long period of agricultural practices of the population which are far removed from any southern or central Indian populations, as pointed out elsewhere by Kennedy.

Part-II of the book opens with the epidemiological transition in a north Indian living population. Kane and Corrucini show that the more recent rural component shows significantly better dental occlusion and identifies the contributory factors. Dash Sharma reviews the status of dermatoglyphic studies in South Asia and pleads for a wider perspective. Rao discusses the problem of inbreeding in India and points out that where there is a long history the effects of inbreeding are only marginal.

Taxonomic distance of the human populations of South Asia has been discussed by Reid. The older paradigm of racial classification has now been replaced by dendrograms and other models. For such studies both anthropometric traits and genetic data need to be used. The genetic distinctiveness of the non-tribals in Maharashtra—is it a solitary example or is general to South Asia ? Is there no genetic separation of Dravidian from the Indo-European speaking groups of South Asia ? Reid raises these questions and makes a plea for more systematic studies. Roychaudhury also discusses the genetic relationships between tribal and neighbouring populations. On the basis of genetic distances he finds the

Bhutanese population to be very distinctive from the other nearby populations. In his dendrogram he groups the Iranians, Afghans, Bengalis, North Indians, Marathis, South Indians and Sinhalese in one cluster and the Malay and the Chinese in another. In a very well documented and detailed article Kailash Malhotra discusses the population structure among the Dhangars, and reports that the frequency of consanguineous marriage in the Dhangar class-cluster is fairly high. He emphasises that geographical proximity has a profound effect on the coefficient of inbreeding. Matrimonial distance and co-efficient of inbreeding show a negative relationship. Weitz analyses the impact of irrigation on the demographic structure of the Peshawar basin. He reports that a Malthusean relationship between production and population growth does not seem to have existed in Peshawar. When the agricultural production peaked, natural population growth declined due to increased mortality. Basu et al discuss the anthropolocal demography of the eastern Himalayan populations. They report that the same socio-cultural factors which affect demographic parameters at low altitudes also operate in the high altitude environment. Beall discusses ageing and growth in the Himalayas. He reports that the age of attaining adult size and function in Nepal is generally later than in the Western sea-level populations. His studies did not confirm the prediction of accelerated growth and development of pulmonary and hematological systems. Biocultural adaptations of the Sherpas of Nepal have been analysed by Weitz. He finds significant differences in the adaptation between the populations of the Himalays and the Andes. In the last but one paper of the volume, Malik and Singh discuss ecology and human physiology in Ladakh. Malhotra and Gadgil conclude the volume with an analysis of the subsistence strategies among the pastoralists of Maharashtra. Their study of the Hatkars leads them to some important conclusions which have a direct relevance to the developmental policies of the Government. They emphasise such trends as replacement of sheep by goats, cultivation of degraded marginal lands etc. which have become manifest in the last few years.

No doubt that the book has become a valuable reference work for all those interested in palaeoanthropolgy and biological anthropology. The volume is very well illustrated with photographs and plots of data. It, however, appears that the two parts of the book—palaeoanthropology and biological anthropology—still stand apart. A closer interaction of these two disciplines and archaeology in actual projects alone will bring about a holistic approach to the problems of palaeoanthropology that an archaeologist is confronted with.

D.P. Agrawal

Recent Advances in Indian Archaeology : Proceedings of the Seminar held in Poona in 1983, Deo, S.B. and K. Paddayya, Deccan College Post Graduate and Research Institute, 1985. pp. 115, Plate 28 Price Rs. 140/-, U.S. $20/-

Research publications from Deccan College have been playing a significant role in the development of Indian Archaeology. The volume on *Indian Prehistory : 1964* brought out as their Silver Jubilee monograph No. 32 is still in use as one of the most important reference books on Indian Archaeology. The monograph under review uses the same format as *Indian Prehistory : 1964* although it is quite clear that it does not propose to perform the same kind of function as the earlier one did or does even today.

Indian Archaeology : 1983 is the proceedings report of a seminar which had apparently laid emphasis on Cultural Ecology as a model in Archaeological Explanations for India. It begins with an introductory note by Deo where he points out that geographical or environmental factors were used in Indian Archaeology almost from the beginning of its history. Sankalia's inaugural lectures on "Indian Archaeology in 1983—As I See It", is the most befitting opening from the leader of the 'Deccan College Movement'. In the speech Prof. Sankalia has touched upon quite a number of problems that Indian Archaeology faces today. The 'information boom' felt by all of us lately is something one cannot cope with while lacking technological aid and Sankalia is perhaps the first among us to have expressed concern about this problem in print.

Paddayya reviews theoretical Archaeology with a view, I think, to educate our field archaeologists. If his aim is what I surmise it is, he has done a wonderful job, Mohapatra attempts to work out the "Cultural Ecology of Early Man in India" and ends with a description that can at best be termed cultural geography. Further, as Misra points out, his climatic reconstructions are extremely general in nature. It is not surprising, therefore, that there is not a single reference to palaeontological finds used by him. Yet, all said and done, Mohapatra makes a brilliant summary of Acheulian adaptational zones in India. The task he has undertaken is huge and he makes a good case for a different approach to lower Palaeolithic study.

Sundara is way off from what we understand by Cultural Ecology which he analyses "Cultural Ecology of the Neolithic India". It is interesting how to an archaeologist most of the phenomena of culture network and the process of their working turn out as non-issues. Complexity in the social network, institutionalization of marriage, family gift as exchange symbol and numerous other behaviour patterns act in combination to afford intensification of the economic base. No cultural ecologist will dream of studying only the latter in isolation.

Dhavalikar's "Cultural Ecology of Chalcolithic Maharashtra" gets closest to the analysis of societal features within a framework of ecological features. This is a new and more meaningful approach in Indian Archaeology. It would have been better if Dhavalikar could also intimate some considerations of population size, population density and population growth as an important aspect within the human ecology. But then, one cannot generate data when he is writing and it is for the future researchers to look into this long neglected aspect of archaeology in India.

In his contribution, Chakrabarti itemizes "The issues in Indian Iron Age" and takes a look into them. He gives call for diverting our interested from the issues regarding the origin of this metal and to "try to understand the Iron Age phenomenon in its economic and cultural aspects in different regions" (page 77). Unfortunately, this is totally lost in the discussions that ensue. The volleys of details on ceramics and their carbon—14 dates still dominate the discussion. It is, once again, missing the wood for the tree. The reviewer feels that Anthropological archaeology and hence Cultural Ecology, cannot develop in India unless we try to solve the basic issues that arise from our data. Cultural Ecology is not a method. It is a model of analysis. How can such a model be borrowed when the data retrieving process does not aim at certain pre-formulated questions? Our data still aims at collecting mainly technology and related economic aspects alone.

In this respect Deo's paper is more down to earth. "The Megaliths : their culture, ecology, economy and technology" is what Deo proposes. He has wisely avoided the catch words of the seminar *Cultural Ecology*; instead, he considers both culture and ecology as important factors without attempting to work out their complex relationship. I wish Deo could use the excellent ethnographic data on contemporary Megalithic builders in India available in literature.

Hegde, as always, is precise and enormously helpful in bringing science to our aid in his paper, "Scientific studies in Indian Archaeology". Surprisingly, he is the one among the various learned participants of the seminar to use ethnographic data on the Agaria Iron working community in Central India. Mate's "Daulatabad" and Gokhale's "Recent Epigraphical discoveries and preliminary analysis of the finds of Kanheri" report the discoveries and preliminary analysis of the finds at these sites.

All said and done, it is an extremely well produced book and like the others that have been published from Deccan College, it will occupy a significant position on the Archaeologist's book shelf.

D.K. Bhattacharya

Archeology as Historical Science, by Bruce G. Trigger Varanasi, 1985, Monograph of the Department of Ancient Indian History, Culture and Archaeology No. 14, Text 71 pp., price Rs. 25/-

The disputes among practitioners of the discipline on the aims and objectives of archaeology have become particularly virulent since the emergence of 'New Archaeology' in the 1960s. Alternatively dismissed as ethnology masquerading in the guise of archaeology and hailed as the harbinger of a new revolution, the debate on the merits of this new approach has been extended to discuss more serious problems relating to the inherent limitations of archaeological data, the relationship of archaeology in different contexts to its sister disciplines and several other allied issues. In this slim monograph Bruce Trigger reiterates his position in this continuing controversy to which he has now, for a number of years, been actively contributing. Trigger's especial interest in this problem is well known from his extensive earlier writings on the subject many of which are available in the collection of essays entitled *Time and Traditions* (1978). The work under review is, in fact, a condensed version of the latter

The focus of this monograph is on prehistoric archaeology—its objectives, limitations and inherent biases. The historical development of archaeology in the West and America has been so divergent mainly because in the former, history provided the dominant framework whereas in the latter it was Social Anthropoly, Trigger has argued. The author's preference for the more historically oriented Western approach over New Archaeology's more ambitious goal of creating general laws of human behaviour emerges clearly. Owing a great deal to Gordon Childe, Trigger finds the Marxist concept of mode of production as being the more valid approach among the plethora of multiple working hypotheses that have been espoused for archaeological explanation. Trigger's well reasoned argument that the only valid generalizations concerning human society can be historical generalizations and not laws universal in their application makes good sense. Only accordingly, can *Archaeology as Historical Science* establish itself.

Lucidly written and readable, Trigger's critique of a number of supposedly new approaches—New Archaeology, Cultural Ecology and ethnoarchaeology, to name only a few - will be well appreciated by all those who have viewed them sanely. At best, archaeological data can only be rearranged through these approaches. Ultimately, the data base itself can only be better utilized through the increasingly sophisticated scientific techniques that have become indispensable over the last few decades to the discipline.

Nayanjot Lahiri

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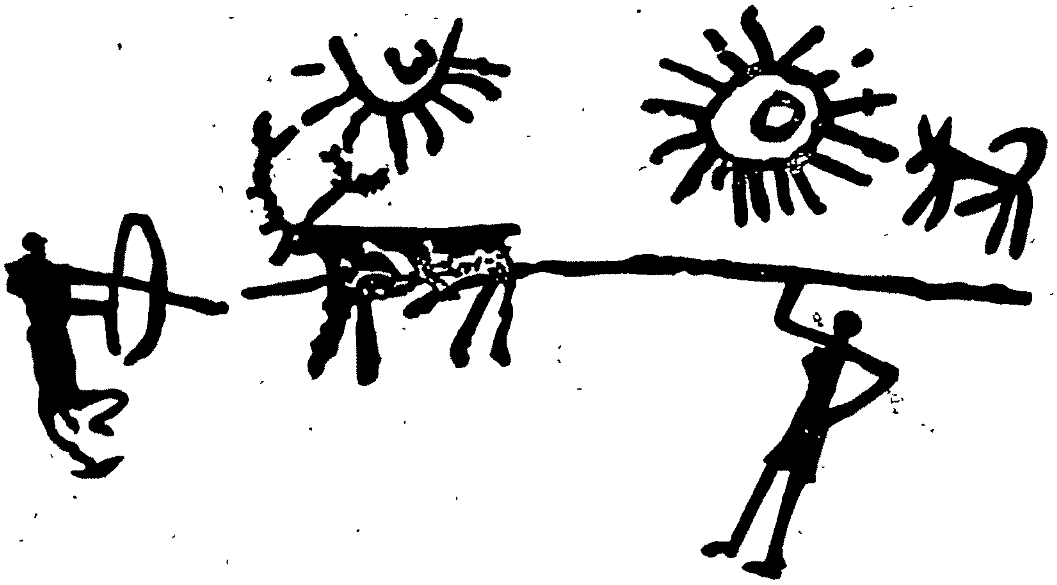

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AND QUATERNARY STUDIES

This issue contains articles presented in the conference of the Indian Society for Prehistoric and Quaternary Studies arranged on the occasion of the Silver Jubilee celebrations of the National Museum. For financial assistance in publishing we are thankful to the National Museum, Department of Culture, Ministry of Human Resources and Development.

Price Rs. 80.00

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EDITORIAL

We deeply mourn the death of Professor G.R. Sharma, a former Chairman of our Society, at the age of 67 in Allahabad. Professor Sharma's contribution to the archaeology of the Vindhyas and the adjacent areas in the Ganga valley will not be forgotten in Indian archaeology. A detailed obituary is being published in our sister journal *Puratattva.*

We have also suffered a deep sense of loss in the passing away of Shri K.C. Verma, a longstanding friend of Indian archaeology. We shall all miss this charming octogenarian in our conferences and seminars.

On the international level we note with regret the demise of Professor A. Leroi-Gourhan (1911-86). Dr. K.V. Paddayya of the Deccan College has sent us the following note on Professor Leroi-Gourhan :

"Leroi-Gourhan (professor at the Faculte des Lettres et Sciences Humaines, University of Paris from 1956 to 1969 ; professor at the College de France, Paris, from 1969 to 1982) has been one of the leading figures in European prehistory and has to his credit a number of publications about Palaeolithic cultures, prehistoric art and religion.

In particular, his excavations at the site of Arcy-sur-Cure have added substantially to our understanding of the contents and chronology of the Chatelperronian culture. Likewise, his analyses of the intrasite distribution of artifacts and structural features exposed in the excavations at the Late Magdalenian site of Pincevent have set a new trend in Palaeolithic archaeology. *Fouilles de Pincevent* (published in 1972 jointly with M. Brezillon) is a veritable store house of techniques and procedures necessary for excavating and interpreting Palaeolithic sites.

Professor Leroi-Gourhan's approach to the study of the prehistoric art of Europe is equally novel. His book *Treasures of Prehistoric Art* seeks to reinterpret the meanings of cave paintings in terms of structuralist principles and ultimately aims at identifying the *Weltanschauung* of artists."

Dilip K. Chakrabarti

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The Chinese Homeland of the "First" Indo-Europeans*

A. K. Narain
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No discovery has created such a mirage as the possibility that so many languages of Europe and Asia are derived from a common origin and that we must look for the original people and their home in antiquity. For almost two centuries now this pursuit has withstood the challenges of science and prejudice alike. The truth may defy but the lure of it is still there. Numerous theories have been advanced to identify this *Urheimat.* I have no intention to discuss them here. Excellent surveys have been made of Indo-European studies.[1]

The discovery and early recognition of Tokharian as a *centum* language in the Chinese parts of central Asia where only *satem* languages could be expected deprived that isogloss of its primary position. It has proved disturbing to many Indo-Europeanists, not so much from the point of view of its linguistic features as from its ethnogeography. The simple dichotomy between the "eastern" and the "western" is no more valid and new expressions and directions are being sought for classifying the language and for locating the speakers of this so-called "centum" or "western" group.[2]

It is generally agreed that in spite of its late appearance Tokharian is a relatively archaic form of Indo-European and it is likely that the speakers of this group separated from their brothers at a comparatively early date. Linguistically Tokharian is isolated. It has no close relatives and is therefore the sole survivor of a language-group on a par with e.g. Germanic or Indo-Iranian and so it is probable that its speakers were not less numerous than the speakers of some of those other groups. They constituted a large and populous nation, divided into numerous tribes speaking divergent dialects.[3]

In the greater part of the first millennium A.D. more than one dialect of the Tokharian language were spoken in the various oases city states which lay on what became famous as the northern silk route of China.[4] More than one people of the region have been identified without doubt as the speakers of Tokharian.[5] It is now proven that Tukhara was the self-designation of these people.[6] Place names and proper names related to, and derived from Tukhara are also known in Greek, Latin, Sanskrit, Prakrit, Tibetan, Arabic and other languages, and they are all in the context of the region from Huanghe to Oxus.[7] But the Chinese had their own names for the various speakers of the Tokharian dialects and they are given in their annals.[8] The leading people among them were named by them as Yuezhi and they insisted in using this name until about the middle of the first millennium A.D. not only for those of them who stayed as their neighbours but also for those who had moved to the west and established themselves in Bactria.[9] At least until the Tang period of Chinese history it has been shown that the name and role of the Yuezhi in one form or another survived in Ordos, Shanxi, Gansu, Qinghai and even in Khotan.[10]

Going backward in time, the best information we have for the first three centuries B.C. is from the well known report of Zhang Qian as preserved by Sima Qian, and in the Annals of the Han dynasties.

Sima Qian states in his *Shiji* (completed *ca* 100 B.C.)[11] that in the *Jianyuan* era (140-134 B.C.) the Chinese emperor Wu was told that

> "the Xiongnu had defeated the king of the Yuezhi and had made a drinking vessel from his skull, and that the Yuezhi had fled and constantly bore a grudge against the Xiongnu, without having (an ally) with whom they could attack them,"

Sima Qian notes later,[12]

> "formerly they (the Yuezhi) were strong and treated the Xiongnu with contempt. But when (the Xiongnu ruler) Maodun (*sic*) had come to the throne, he attacked and defeated the Yuezhi, and finally the *Laoshang* chieftain of the Xiongnu killed the king of the Yuezhi and made a drinking vessel from his skull. At first the Yuezhi had been living in the region between Dunhuang and Oilian (Western Gansu) (but), when they had been defeated by the Xiongnu, they went far away. They passed through Dayuan and to the west (of that country), they smote Daxia (Bactria) and subdued it. Subsequently they had their capital north of the Gui river (Oxus), and (this) they made their royal court. The remaining small groups who had been unable to go away maintained their position (among) the Qiang of Nanshan (region of Karanor); these are called the 'Lesser Yuezhi.'"

The account given above is from the chapter 123 dealing with Dayuan. In an earlier chapter 110 dealing with the Xiongnu Sima Qian informs,[13]

> "At that time (c. 220 B.C.), the Eastern Hu were powerful and the Yuezhi strong. The chief (Shanyu) of the Xiongnu was named Touman. Touman could not withstand the (Chinese) Qin (dynasty) and migrated to the north."

When the power of Qin waned the Xiongnu came back and occupied again the Ordos region. The Xiongnu crown prince was Modun, the future founder of the first Xiongnu empire. Touman wanted to make a younger son crown prince and to get the rid of Modun.

> "He then sent Modun as a hostage to the Yuezhi. And when Modun had become a hostage among the Yuezhi, (his father) Touman suddenly attacked the Yuezhi. The Yuezhi wanted to kill Modun, but Modun stole a good horse from them, and having mounted it he fled and returned (to his country)."

In 209 B.C. Modun killed his father and became Shanyu. Shortly afterwards he waged war against the Eastern Hu and routed them.

> "After having returned (from this campaign), he went to the West and smote and chased the Yuezhi and going to the South he conquered Loufan. . ."

In the description of Xiongnu titles and ranks :

> "The Kings and Generals of the Right dwell in the western part (of the Xiongnu territory), up to the region west of Shang commandery (N.E. Shensi) where they border upon the Yuezhi, the Ti and the Qiang."

In 177 B.C. the Xiongnu chieftain who bore the title of *yu xian wang* undertook raids upon the northern frontier, by which the precarious peace between the Han and Modun's Xiongnu confederation was endangered. Modun wrote in 176 B.C. a letter to the Chinese emperor, in which he pointed out that the *yu xian wang's* raids had been provoked by the outrageous behaviour of the Chinese officials in the frontier region.

> "Now since these small officials have spoilt the treaty (between our countries) I have punished the *yu xian wang*, and sent him to the west to seek the Yuezhi and to attack them. By the good fortune (bestowed by) Heaven, by the good quality of our officers and soldiers and by the strength of our horses, he has des-

> troyed and exterminated the Yuezhi; he has completely beheaded and killed, subdued and vanquished them. (Moreover), he has pacified Loufan, Wusun, Hu Qian and twenty-six adjoining countries, and all these have been made Xiongnu (territory): all the peoples who draw bows have been united into one family. . ."

The decisive battle against the Yuezhi had already taken place in 177/176 B.C. Shortly after 174 B.C. Modun died, and his son Jizhu succeeded him; he bore the title of Laoshang shanyu. According to the account of the Yuezhi in *Qian Hanshu* it was under this *shanyu* who died in 160 B.C. that the Yuezhi began their trek towards the west. Pan Gu confirms the basic facts recorded by Sima Qian. He notes in Ch. 96 that,[14]

> "The Great Yuezhi originally formed a nomadic state; they moved about, following their cattle, and had the same customs as the Xiongnu. As their archers numbered more than a hundred thousand, they were strong and treated the Xiongnu with contempt. Originally they lived between Dunhuang and Qilian. But when the *shanyu* Modun had attacked and defeated the Yuezhi, and when the Laoshang *shanyu* had killed the (King), and had made a drinking vessel from his skull, then the Yuezhi went far away. They passed through Dayuan (Ferghana). and to the west (of that country) they smote Daxia and subdued it. They had their capital north of the Gui River (Oxus) and (this) they made their royal court. The remaining small groups who had been unable to go away maintained their position (among) the Qiang (proto-Tibetan tribes) of Nanshan (region of Kara-nor); these are called the 'Lesser Yuezhi'."

Thus according to *Shiji* and *Hanshu* the Yuezhi originally lived between Dunhuang and Qilian. They were very strong among the peoples west of Yellow River. They were stronger than Xiongnu and held the balance of power until they suffered a decisive defeat at the hands of the Xiongnu, and the chief ruling clan, the Great Yuezhi, left their homeland for the west.

But the Yuezhi were known to the Chinese from much before third century B.C. Attention has been drawn to a variety of forms of the name Yuezhi in Chinese antiquity and to a much wider extension of their space and time by Haloun in his erudite article.[15] The questions he asked were different from ours and his conclusion that the Yuezhi were of Scythian stock is not acceptable to many.[16] But even those who differ from him are inclined to accept his findings about the presence of the Yuezhi in China in the 7th century B.C.[17]

In *Yi Zhoushu* (*Juan* 7, Ch. 59, "Wanghui")[18] we are told:

> "(In the court of the king Cheng), the second king of the Zhou Dynasty [ca. 1110 B.C.])...the envoy of the Yuezhi stands on the north of the court and tributed *taoyu* (which, according to the *Shiji*, was a special kind of horse of the Xiongnu)."

In the Appendix to the same Ch. 59, "Yiying xianling"[19] we are informed:

> "(The king Tang, the first king of the Shang Dynasty [ca. 1770 B.C.], asked his premier Yiyin, to have his subordinates present their native products in tribute. Therefore, the premier Yiyin listed all the native products of the Shang subordinate races according to their location)....... On the north, there are Shache, Xiongnu, Yuezhi, Loufan, Tung Hu..., who contribute horses, white Jades, and bows."

In the further paragraph also the record mentions that the native products of the Yuezhi were horses. That, both the horse and white Jade were items associated with the Yuezhi is clear from these early sources. In *Mu tianzi zhuan*[20] we are informed:

> "Since the day of *rensheng*, Mutianzi travelled (from the Zhong) westwards. At the day of *jiaxu* he arrived at the Red Wuzhi...... Red Wuzhi is the place producing beauties and Jade." (*juan* 2)

> "... from the Zhong westwards to the Red Wuzhi, the (total distance is) three hundred *li*." (*juan* 4).

Though it is difficult to determine the present location of the Zhong Shan, it seems to be a mountain around the curve of Huanghe (Hetao) according to Ogawa[21] and Zhang.[22] From there westward Mu tianzi spent three days (from the day of *renshen* to the day of *jiaxu*) on the way to the Red Wuzhi, which means that this was not too far from nuclear China.

In *Guanzi*[23] there are several references to the Yuezhi Jade :

> "... using the Jades of the Yushi, which was located to the north."
>
> "The Jades were produced in the *bordering mountains* of the Yuchi. The distance between the Chinese royal court and here is seven and eight hundred *li*." (Chapter 78, "Gui de pian")
>
> "If the Yuzhi does not send envoys to our court could you order them to tribute white Jades ? .... If you reward them with thousands of money for the white Jades, then the Yuzhi from eight thousand *li* away would send envoys to our court." (Chapter 80, "Qin zhong [A]")
>
> "The Jades were produced along the *bordering mountains* of the Yuzhi. It leaves the Zhou royal court away about seven thousand and eight hundred *li*. The way is far, and the road is hard to travel. Therefore, the previous kings valued the Jades and used them as currency of the upper class." (Chapter 81, "Qin Zhong [B]")

The dates and authenticity of these sources may be disputable but no doubt it confirms that the name of the Yuezhi in one form or another was known to the Chinese in the pre-Han period.[24] Also, there is no way to check the semi-legendary geography of the Yuezhi but historians and archaeologists have begun realising that traditions and legends cannot be dismissed lightly. In any case *Shiji* which is a reliable text does vouchsafe about the Yuezhi in the seventh century B.C. in the following reference.[25]

> "During the reign of Duke Mu (659-620 B.C.), with the assistance of the premier Yu Yu, the eight barbarian tribes of the west were subordinated to the Qin . . . ." (The Wuzhi=Yuezhi were included in the list of these eight.)

The distances mentioned in *Mu tienzi zhuan* and *Guanzi* indicate that the Yuezhi were spread over an area the nearest point of which was 300 *li* and the farthest about 8000 *li*, which means that their geography spanned from almost the borders of the nuclear China to about 2000 miles west, not at all unreasonable in the light of our information about the various Tokharian speaking peoples owing allegiance to the Yuezhi in the 3rd century B.C.

At any rate Haloun, Pulleyblank and even Henning are willing to accept the presence of Yuezhi on the borders of nuclear China from very early times, although their objectives are different. They all however assume that the Yuezhi in China were an external element. Pulleyblank discussed the matter of the origins of Chinese civilization and thought of Indo-European influence on it. He refers to the Kurgan theory of Marija Gimbutas and the wide spread of the Kurgan culture and tradition from the Pontic and Volga, through the steppes of Central Asia as far east as the Yenissey in Siberia.[26] Based on Gimbutas' view Pulleyblank[27] thinks that :

> "we should have the easternmost extension of the Indo-Europeans on or within the present boundaries of China already in the third millennium. Even if one insisted on a European origin for the Indo-Europeans they would have been there by the latter part of the second millennium when the Shang civilization was emerging. The probability that there were contacts with the emergent civilization of China is surely very great in either case."

Without going into the question of the origins of Chinese civilization, what is relevant for our discussion is that two eminent experts in Chinese studies, Haloun and Pulleyblank, agree about the presence of the Yuezhi in China "by the latter part of the second millennium B.C." or at least at the beginning of the first millennium B.C.

Now the moot point is whether the Yuezhi and other Tokharian speaking peoples were autochthonous in China or did they come from outside. The existence of a *centum* language and its speakers in the far east was so disturbing to those who believed in the simple "eastern" and "western" division of the Indo-European that it was assumed by scholars like Bosch Gimpera[28] that this must mean that at some comparatively recent time, at any rate after the original splitting up of the Indo-European, a western *centum*-branch of the family had moved eastwards into the Tarim basin, passing right through the territories of the Balts, Slavs and Iranians, who had *satem* dialects. But Pulleyblank has rightly noted that,[29]

> "this was never a very convincing hypothesis historically and no real evidence has ever been brought forward to substantiate it, but it seemed necessary to account for the linguistic facts."
>
> "... a better understanding of the linguistic evidence has made it no longer necessary to do so. It has become clear that the supposedly western features of the Tocharian (*sic*) languages are better explained as survivals in peripheral areas of features that were once found in common Indo-European."

It is clear in fact from Lane's study that an early separation from the common stock was followed by a long period of considerable isolation and contact with non-Indo-European languages.[30]

A desperate search has been made to find the equivalent of the Chinese name Yuezhi in sources outside China. The equivalence to *Tukhāra*, which was in fact the autonym of the people, and its variant forms in Greek, Latin, Sanskrit and other sources did not take them beyond Bactria in the west and India in the south and that too in the historical period. There is no need to discuss all the identifications that have hitherto been advanced for Yuezhi. Suffice it to note that while one group of scholars sought to identify the Yuezhi with one or the other people mentioned in western sources to indicate a Scythian or Iranian association others maintained their Tokharian connection. The view of the first group is now becoming out of vogue. We still do not know for sure, and can only speculate, the contemporary Chinese pronunciation of Yuezhi. Pulleyblank in his recent study on the reconstruction of Old Chinese has favored a term mentioned in Ptrolemy's geography as the western equivalent to Yuezhi and sees in Dayuan the actual word Taxwar, which was the basis for similar Greek terms.[31] But Henning has given reasons to reject Pulleyblank's restoration on the basis of Karlgren's postulation and an ancient Sogdian example.[32] According to Henning[33] the two Chinese characters which were fixed as standard orthographs for the name *Guti* shortly before 200 B.C. are pronounced as Yuezhi in modern Mandarin and that his "new equation is preferable to all others : *Guti* Yue-chih are perfect equivalents." He also identifies the Tukri with the Uighur-Turkish name for the "Tokharian-A," and the speakers of the "Tokharian-A" as the Guti, a name which later on became Kuci.[34] As Henning notes, "linguistic evidence in support of identifying the Guti (and Tukris) with the Proto-Tokharians can hardly be expected ; for virtually nothing is known of their language."[35] But he does find some hints in the personal names of the Guti kings for a Tokharian connection.[36]

This discovery of Henning is no doubt significant and merits much attention. Not only the Guti and the Tukri belong in the West Asian history but also, as Henning[37] has boldly announced :

> "they could claim to be the first Indo-Europeans in history ; for their appearance in Persia precedes the arrival of the Hittite nations of Asia Minor."

The lands of both the Guti and Tukri were included in the dominion of Sargon of Akkad.[38] Of the two, the Tukri are comparatively rarely mentioned in the records. The one king of Tukri ever reported is Kiklipatalli and he is accepted as an instance of mythical history.[39] Nothing is known about their exploits or roles, or movements in any direction except their name as a people of their lands in the earlier and longer list of Sargon's dominion or in the later and shorter list in the inscription of Hammurapi.[40] But in any case both the Guti and the Tukri (along with other peoples who have not been taken into account by Henning) were people from the highlands and spoke languages which were considered 'crabbed' or intricate' by Hammurapi.[41] Probably they were external elements in the area.[42] The Guti became more notorious in West Asian history. Naram-sin, one of the great conquerors in Babylonian history, had to suffer a great defeat at their hands.[43] The Guti kept Babylonia in subjection for well over a hundred years.[44] But finally their last king, Tirigan, was overthrown and killed by Utu-hegal of Uruk.[45] There are not many records to tell us about the actual conditions of Babylonia during the rule of the Guti. Utu-hegal described them as : "a viper of the hills, an enemy of the gods, who had carried the kingship of Sumer with evil."[46] Their descendants are mentioned in later records. They were also known as Qutu. They appear most prominently in the campaigns of Assyrian kings towards the end of second millennium and subsequently.[47] In adversity they figured as merchandise in the slave market. If the word *namry* denotes the light color of the skin the Guti differed ethnically too from others in the area from the lowlands.[48] In course of time they appear to have become extinct or merged with other peoples of their own group or even with their close relatives the Hittites, after they met with them.

The question arises now. What was the original home of the speakers of the Tokharian languages ? Which way they moved ? To answer these questions Henning has made a series of assumptions :

(i) That, since "all Indo-Europeans of Asia, sooner or later, come within the view of the civilizations emanating from Babylonia, there is no good reason for excepting the Proto-Tokharians from the common fate : they will have made their debut somewhere in the Near and Middle East." They should have set out their migrations rather early ; "earlier, at any rate, than the Indo-Iranians, who spoke a highly developed (therefore probably later) form of Indo-European. Moreover, as some of the Indo-Iranians after their division into Iranians and Indo-Aryans appeared in Mesopotamia about 1500 B.C., we should expect the Proto-Tokharians about 2000 B.C., or even earlier."[49]

(ii) That, these Proto-Tokharians had "freshly arrived" in Persia within the lifetime of Naram-sin by way of Caucasus. He finds in their movement a parallel situation of later history, that of the Kimmerians and Scythians.[50]

(iii) That, after the overthrow of Tirigan, the Guti, along with their "brother-nation" Tukri, left Persia for China and there they took over huge territories, including most of Chinese Turkestan, a portion of China proper and a part of Gansu to the west of the Huanghe. A small remnant of the Guti "that had adopted settled habits was left behind in the Lower Zab region" and "is mentioned from time to time in later centuries as one of those noisome hill tribes on the northern frontier, that need to be punished by a military expedition." He believes that "the Guti never truly settled in Babylonia but merely exploited and gradually ruined that country." He states that the Guti and Tukri, who were closely allied, "came together to Persia and left it together shortly before the end of the third millennium."[51]

(iv) That, these Guti=Yuezhi, "after having enjoyed the fruits of their empire for a long period," but finally having been overthrown by the Xiongnu, "set out in the general direction of Persia," but "came to a halt in Bactria." "Possibly dim memory had been preserved among them of a pleasant land far to the west whence their ancestors had come." Again, several small groups stayed behind. Henning finds in this second century B.C. movement of the Great Yuezhi to the west "for once history truly repeats itself."[52]

But these assumptions are unwarranted. Without going into Henning's predilection for Babylonia and Persia, the only part of his *first* one that would find general acceptance is that the Proto-Tokharian movement should be placed earlier than the Indo-Iranian on linguistic grounds. He may also be right in guessing the date of the arrival of the Proto-Tokharians in the west.[53]

His *second* assumption has no basis. The Guti and Tukri were not fresh arrivals in Persia in the time of Naram-sin (2291-2255)[54] because they were already there in the time of Sargon. They are mentioned in the list of peoples whose lands were included in the dominion of Sargon. In fact some scholars consider them as natives in the highlands of Persia. Their arrival from Southern Russia via the Caucasus is equally unfounded. In the case of the Kimmerians and the

Scythians, in spite of the lack of unanimity of views, at least there is some evidence in the accounts of Herodotus and in archaeological findings ; but what do we have to bring the Guti and Tukri from there ? Even Ungnad,[55] held in high regard by Henning places the ultimate origin of the Guti in the east, by which, as Henning admits, he meant Russian Turkestan ; [56] but Henning has no special reason to reject Ungnad's suggestion. Moreover, the northern origin cannot be reconciled with the mythical history about the prehistoric Elamite king, Autaluma and Kiklipatalli, the Tukris king, to which Henning himself has subscribed.[57]

The third and fourth assumptions are even weaker than the second one. In the case of the Guti=Yuezhi repeating history in the second century B.C. and making a journey to the west at least we have the evidence of the Chinese annals about their leaving for the west after their overthrow by the Xiongnu.[58] But in the case of the Guti and Tukri leaving the west for the east after their overthrow by Utu-hegal of Uruk what evidence do we have ? None. Neither archaeologieal nor literary—even of semi-historical value. On the other hand, the continued presence of the Guti in the west is well attested until much later times. Henning contradicts himself when he states that "the Guti never truly settled in Babylonia but merely exploited and gradually ruined that country"[59] because even by his own account they did after all live there for a couple of hundred years and he also admits that some of them adopted settled habits and stayed in the Lower Zab region and gradually merged in the population.[60]

Before leaving Henning I cannot help quoting from the very first paragraph of his article,[61]

> "One of the Indo-European tribes that sought a home in Asia is distinguished from all others by its *apparent lack of energy and vitality* : that is the tribe whose descendants spoke the languages known as 'Tokharian'. By *nature isolationist,* they chose to make permanent settlements in a remote region in the heart of Central Asia—a chain of oases along the northern edge of the Great desert of Chinese Turkestan, at the foot of the Tien Shan mountains—*for which there was little or no competition.* When the Chinese first encountered this tribe in the Ist century B.C. (*sic*) *they did not even recognise it as constituting a distinct ethnic unit and failed to give it a name,* such as they had for their neighbours to the north and east." (Italics are mine)

It is difficult to agree with the aspects of the statement I have italicised above.

But two facts stand out clearly from Henning's own investigation. First, that the Proto-Tokharians were not autochthonus in the West Asian region and that they were external elements, and second, that they were known in the region before the coming of the Hittites.

Now if they came from outside we should believe either with Henning that they came from Southern Russia in Caucasus or from elsewhere. There is hardly any evidence for the first alternative.[62] The second alternative takes us to the east. Apart from Ungnad's suggestion for Russian Turkestan[63] we have the hypothesis of Pulleyblank who accepts the presence of the Yuezhi within the boundaries of China already in the third millennium B.C.[64] The hypotheses of Ungnad and Pulleyblank are in fact based on the Kurgan theory of Marija Gimbutas and the findings of Russian archaeologists. According to Gimbutas the Kurgan culture extended from Volga in the west to Yenissey in Siberia in the east and that toward the end of the third millennium this culture was moving westwards and southwestwards into the Black Sea and Caucasus areas, and still later farther west on into Europe.[65] This fits in with the first appearance of the Indo-Europeans in the west by the early part of the second millennium B.C. Gimbutas has made further studies in the field and although her main concern is of course related to identify the ancestral Indo-Europeans in the west and to clarify movements of peoples and ideas in ancient Europe,[66] she is clear about the easternmost extensions of the Indo-Europeans. The sequence and geography of the Afanasievo, Andronovo and its various units, and Karasuk cultures established by the Russian archaeologists[67] as well as the study of Jettmar[67] spell out clearly that we should look out if at all for the home of the first Indo-Europeans, in a more easterly direction than westerly. Moreover, it is becoming increasingly clear now that these cultures we are discussing are spread out from Kazakastan to the Altai region and are related to the Scythians or Sakas. And, there is no doubt the Tokharians were situated to the east of the '*satem*' speaking Sakas or Scythians.[68] If Haloun is correct in identifying the Xianyun with the Cimmerians,[69] perhaps their movements were related to inter-tribal situations created by the Yuezhi. The view of Chlenova who would identify the population of the Karasuk culture as a branch of the Tokharians is relevant to our discussion.[70]

All this so far is in keeping with the earliest historical and semihistorical information we have about the presence of the Tokharians in Gansu and adjacent areas. And as Pulleyblank has noted it is unlikely that they were recent intruders nor is it clear where they could have come from. The archaeology of Chinese Central Asia at this stage would be very useful. It is true that work in that area is not so prolific as in Soviet Central Asia or as in West Asia, but we must argue from what we have at present. Here again, Xinjiang is less explored than Gansu but it is the latter area which is more relevant for the Tokharian-Yuezhi homeland. Before we take notice of the Gansu material I must state that I have no intention here of going into the problem of the origins of Chinese civilization. Whether it is its own miracle or it needed some external stimuli let others decide. What is significant for us to note is that in Gansu and adjacent areas there is a remarkable continuity of local cultures from the neolithic times to the early historic[71] and that there is no evidence of distinctly foreign intrusion.

Pulleyblank[72] considered the possibility of identifying the Qijia culture in Gansu and Qinghai as Tokharian. He also notes "certainly it should ultimately be possible to identify the Yuezhi either with some of the descendants of the Qijia culture or with some as yet undiscovered archaeological remains in those regions." It is not always easy to recognise the ethnic identity of a people on the basis of their material culture and so whether or not Qijia or any other culture in the regions of Gansu and Qinghai belong to the Yuezhi will remain a moot point until more work is done there. But nonetheless the point is not lost. For if the historical and semi-historical sources report the presence of the Yuezhi in the region from about 1100 B.C. and if there is no evidence of foreign intrusion in the development of the local material culture it cannot but be a significant indication that the people who lived in that area, in this case the Tokharian-Yuezhi, were there from times immemorial.[73]

In the latest edition of his work on Chinese archaeology Kwang-chih Chang[74] states that the Qijia culture in Gansu followed the Yang-shao but preceded the Zhou strata in the upper Weishui as well as several other contemporary local Aeneolithic cultures to the west. The Qijia was a culture of advanced farmers, among whom domesticated animals were of apparently greater importance that they were in much of the rest of North China. They made tools and implements in copper. An analysis of a knife and an awl disclosed that copper accounts for over 99 percent of the total metal used in their manufacture, with impurities (lead, tin, etc.) less than 0.4 percent. Two radio-carbon dates from one of the sites, Dahojuang, place the Qijia culture in the 2150-1780 B C. range and make its copper artifacts one of the earliest-dated metal finds in China. Kwang-chih Chang observes[75] that

> "without question, Qijia represents the culture of farmers, and their farming tradition was probably introduced from the Yangshao culture."

Making allowance for disputes about its cultural affiliations he notes further that

> "it is possible that in this area, which is adjacent to the dry steppes of northwest China and Inner Mongolia, and where the climatic conditions of the present time tend to be on the arid side, the. Yangshao farming culture was not well adapted and, was replaced by cultural phases having a native sub-Neolithic base but receiving considerable cultural influence from the Yang-shao farmers. The nature of its contemporary cultural phases and the many local cultural traditions which followed the Qijia seem to indicate this possibility."

He adds,

> "Stratigraphic evidence in eastern Gansu and eastern Qinghai shows that Qijia culture was

followed by several small local cultural phases which carried on the painted pottery tradition."

Whatever may be the controversy about the composition of the Qijia culture and the element of change in it, the fact remains that there is nothing to bring in anything from West Asia or even from regions west of the Tianshan. So far, exchange of goods which have been noted between China on the one hand and Iran or other areas in the far west in the pre-historic period do not date from before the second millennium B.C. and it is significant to note that while goods of Chinese origin are found in the west there is hardly any item of western origin found in Gansu and for that matter even in the fringes of Tokharian homeland until we enter the first millennium B.C. by which time the "First" Indo-Europeans had already opened the door to the west.[76] I would venture to suggest that even the Yangshao, which preceded the Qijia, could be the culture of the autochthonous Tokharian speaking people or other "First" Indo-Europeans speaking one or the other of the *centum* languages whose linguistic remains, unlike that of the Tokharians, have not survived.[77]

As I have mentioned earlier this is not to discuss the question of the origins of Chinese civilization or whether it was the Indo-Europeans who *brought* the horse and chariot to China as raised by Pulleyblank. If at all these are questions which can be examined independently. The apologia of Pulleyblank that he was not saying "there *was* an Indo-European invasion of China"[79] is in fact unnecessary. I do not think that the Shang culture of warlike states with centralized government needed a "powerful shock" from the west to develop. If Indo-European is a linguistic term and not racial, I do not see any problem in finding the "first" Indo-European in Gansu and adjoining areas in the neighbourhood of the speakers of the Chinese language to the east and south of them. Needless to say the ethno-linguistic geography of the latter people in those days did not coincide with the present expanded geopolity of China. It is the nation-state approach in historiography which has given sting to such discussions.[80] If we view history only in light of movements of peoples and ideas this sting does not work. The Yuezhi movement from the east to the west in the second century B.C. was not a *rebound* journey to the west but the *last* movement of the "first" Indo-Europeans out of their primary homes. In fact some of those who still remained behind, the Little Yuezhi, never came out but became part of the melting pot of the Chinese world.

I come to the conclusion therefore that the Yuezhi (=Guti) were living in China, west of the Yellow river from times immemorial and were indeed not only among the "first" Indo-Europeans of history—of course, in the limited sense in which history has been viewed by most scholars in the west—but also the ones who moved out of their homeland last. Some of the "first" Indo-Europeans might have left home as early as the third millennium B.C. They included peoples like the Hittites and the speakers of other *centum* languages. These movements covered the third and second millenniums B C. We must visualise several waves, and several stages, of these movements based on natural and human factors. These westward movements of the "first" Indo-European—in the sense of all the *centum* speakers, disturbed other Indo-Europeans whom they met on their way and who spoke the *satem* languages whom we may call the "second" Indo-Europeans. They always lived west of the "first" Indo-Europeans. These "second" Indo-Europeans included the various Iranian and Indo-Iranians, and the Sakas. The latter included the Cimmerians, the various Sakas of the Old Persian inscriptions and Indian sources, the Scythians of Herodotus and the later Sakas, Sarmatians and kindred tribes. A discussion of the chronology and geography of these "second" Indo-Europeans is outside the scope of this paper. Suffice it here to say that while archaeology is ambivalent in providing a pattern of movement direction, early historical records do confirm the pattern of history repeating itself It is well known now that the Yuezhi moved from China to Afghanistan in the second century B.C. and in the process again forced peoples of the Saka origins to disperse and found new habitations in southern and western Asia, and even in southeast Europe. Archaeology has just begun confirming this process already known to history and tradition as well. No doubt much work and less pre-suppositions are needed before the movements of the "first" and the "second" Indo-Europeans can be detailed.

NOTES

*The essentials of this paper were presented in part at the 28th session of the International Congress of Human Sciences in Asia and North Africa, at Mexico City, in 1976, and in part at the 29th session of the same congress at Tokyo/Kyoto, in 1983.

1. Mallory, 1973 : 21-65. Crossland, 1971 : 824-1003.

2. See for example, Adams, 1984 : 395-402, which places Tokharian in Meiller's "Northwestern" group, with particularly close ties with Germanic. Its ties with both Greek and Indic is supposed to reflect later contacts on the part of the pre-Tokharians with the pre-Greeks and pre-Indics as the pre-Tokharians moved progressively eastward in the later Proto-Indo-European world. But there are other conflicting views too and the nature and extent of contribution of Tokharian to our knowledge of Indo-European relationships is still under discussion.

3. Henning, 1978 : 216. Two dialects A and B of Tokharian are well known but the possibility of yet another has already been noted, Burrow, 1935 : 667-675. Even this third dialect is known from its usage in the Far East only. Also, this discovery in Shan-shan and Lou-lan (Kroravina) takes the antiquity of the usage of the language at least five hundred years earlier than the documents found in A and B dialects.

4. Documents in Tokharian 'A' and 'B' dialects have been found from Kucha, Turfan and Qarashahr, and evidence for yet another dialect comes from the Kharosthi documents of Shan-shan.

5. Apart from the Yuezhi and peoples of Kucha, Turfan, Qarashahr and Shanshan (Loulan), the list includes Yancai and Suxie in the west and Jushi around Turfan and those of Aqsu, Kangju, Wusun and Dayuan.

6. Bailey, 1970 : 121-122. For the first time bilingual text has offered a rendering "woman of Kuci" for Buddhist Sanskrit *Tokharika*, *Kucanne Iscake*. It had long been known that Kumarajiva (born in Kuci) and Gunavarman had equated Sanskrit *tukhara* with the Chinese Yuezhi.

7. Cf Latin : *tochary* with ms. variants including *thogarii*. Sanskrit; *tuṣāra*, *tukhāra* with variants *tukhāra*, *Tuṣkāra* ; Prakrit : *tukhāra* ; Tibetan : *thod-kar*, *phod-kar* in the east, *tho-gar*, *tho-dkar*, *tho-kar* in the west ; Khotanese Saka *ttaugara*, etc.

8. See the list of countries/peoples described as part of "Western Regions" in Zhang Qian's account given in *Shiji*, 123 (trans. by Watson, 1961 : 264 f. ; Zurcher, 1968 : 358-63) and *Qian Hanshu*, 61 (trans. Hulsewe and Loewe, 1979 : 207 f. ; Zurcher, 1968 : 363-66).

9. See *Hou Hanshu*, 118.9a (Zurcher 1968 : 367-71) ; *Sanguozhi Weishi*, 3.6a (Zurchar, 1968 : 371) ; *Comm. Weichi*, 30.2ab (Zurcher, 1968 : 371) ; *Beisht*, 97.11b (reproduced in *Weishu* 102.8b) ; Zurcher, 1968 : 375).

10. Pulleyblank, 1966 : 18.

12. *Shiji*, 123.3b. Zurcher, 1968 : 360.

13. *Shili* 110.5b, 6a, 7a, 8a, 10b, also in *Qian Hanshu*, 94A.5a, 5b, 6b, and 11a ; Zurcher, 1968 : 361-353.

14. *Qian Hanshu*, 96 A. 14 b ; Zurcher, 1968 : 364-365 ; Hulsewe and Loewe, 1979 : 120-21.

15. Haloun, 1937 : 243-318.

16. Pulleyblank, 1966 : 16, 29, Henning, 1978 : 222-23.

17. *Ibid.*, 1966 : 17-19, 29 ; *Ibid*, 1978 : 223.

18. *Yi Zhoushu jixun Jiaoshi* annotated by Zhu Yuzeng, Taibei : Shiju Shuju, 1967, p. 194.

19. Ib, p. 199.

20. *Mu tianzi zhuan* of Kuo Pu, annotated by Hong Yixuan. In Longxi Qingshe Congshu, vol. 15. But see also the translations by Cheng Te-kun, "The Travels of Emperor Mu", *Journal of North China Branch of Royal Asiatic Society*, 1932, pp. 124 ff., esp. p. 135, and Remi Mathieu, *Le Mu Tianzi-zhuan*, Paris, 1978, pp. 32-33. I am following Haloun and Pulleyblank.

21. Ogawa, 1929 :

22. Zhang Gong Liang, 1935 : 6-15.

23. *Guanzi Jiaozheng*, annotated by Yin Zhi zhang, Taibei reprint. *Guanzi Jijiao* 2 vols., annotated by Guo Moruo, Wend Yiduo, Xu Weiju Beijing : Kexue chubanshe (1956).

24. Pulleyblank, 1966 : 19.

25. *Shiji*, 110. , Watson, p. 158.

26. Gimbutas, 1963 : 815-836. Pulleyblank, *op. cit.*, 15.

27. Pulleyblank, 1966 : 15.

28. P. Bosch Gimpera, 1961 : See also Fairservis, 1959.

29. Pulleyblank. 1966 : 13.

30. G.S. Lane, 1958 : 252-261.

31. Pulleyblank, 1962 : 93 sq., 106 sq., 109,

32. Henning, 1978 : 221.

33. Henning, 1978 : 225-226.

34. To avoid confusion with the linguistic designation 'Tokharian' Henning prefers to call the speakers of these languages provisionally as the "Proto-Tokharians" (Henning, 1978 : 216).

35. *Op. cit.*

36. Henning, *op. cit.* 227-228.

37. *Ibid.*, 226.

38. Sargon's dates are 2371-2316 (Gadd, 1971 : 995), ca. 2530-2475 B.C. (Cameron, 1936 : 27).

    The 'geographical survey' of Sargon's dominions includes the lands of Arrapkha, Lullubi, Armanum, Gutium, Parashi, Tukrish, Anshan, and Elam, which taken as a whole, might be regarded as comprising almost the entire mountainous region in south-western Persia (Gadd, 1971 : 432-433). See also Albright, 1925 : 195 f.

39. Henning, 1978 : 220 ; Speiser, 1948 : 10a ; 1956 (he transcribes the name as Kiklib-adal and states that the complete form is *ki-ik-li-pa-ta-al-li*). He observes that "the name is plainly Hurrian and the land in question is the name which Hammurabi described as using an *egru*-tongue. in common with Subartu, Autium and Elam (?) ; Ungnad, 1936 : 18-19 Henning has accepted this instance of mythical history to show the antiquity of the Tukri.

40. Gelb, 1944 : 41. Speiser, 1948 : 7a, 8a, 9b. Ungnad, 1936 : 18-19, 210. For Sargon's list, Gadd, 1971 : 533 and for Hammurapi's list, Gadd, 1971 : 624, 639.

41. The word *egru* has been variously translated as "queer' (Henning, 1978 : 220), "intricate" (Speiser, 1948 : 7a, 8a), "complicate" (Gelb, 1944 : 41).

42. From the text of the Hammurapi Inscription mentioned above it is clear that they were foreigners in the area. Not only their language was different but they were also distinguished by their much fairer skin than the Mesopotamians to whom they long provided an ample supply of slaves (Rene Labat, 1975 : 504). But according to Rene Labat out of the four major ethnic groups : the Subarians, the Hurrians, the Lullubi and the Guti, the two latter "were native to the area" ; they stayed in the mountains from where they constantly menaced Mesopotamia.

43. Cf. Th. Jacobsen, 1939 : 207.
    But doubts have been expressed on the involvement of Naram-sin in the downfall of his realm, see Falkekstein, 1963 : 461-472, esp. 466-69.

44. Jacobsen, *op. cit.*, 138 n. 10a, has calculated 91 years, but in some of his sources the total period comes to 124 or 125 years.

45. Jacobsen, *op. cit.* 139, n. 11.

46. Jacobsen, *op, cit.* 839, n. 11. But, "from what little we know of their social structure, during the period when they occupied Mesopotamia, we can see that they formed a sort of tribal confederation of rough and simple people. They were led by a military aristocracy which elected a "King" for a fixed, but short, period of time." (Rene Lebat, 1975 : 505).

47. Gadd, 1971 : 444.

48. Henning, 1978 : 220 ; Rene Labat, 1975 : 504. In connection with their being in the slave market it has been observed that they were light-skinned and so physically distinct from the local people. But this depends upon the interpretation of one word *Namru*, which has been translated by some as "light" (cf. Ungnad, 1936 : 104 sq. ; Gelb. 1944 ; 43 n. 138), as "bright" in the sense of "intelligent" (cf. Speiser, 1930 : 100-108 ; 1948 : 12 sq.). Henning remarks that as the meaning of the word is disputed, it may be wiser not to rely on it. But he also notes that "it is in any case not seriously in doubt that the Guti differed ethnically from the people of the lowlands."

49. Henning, 1978 : 217. On p. 219 Henning notes "it would be consonant with the present-day opinion if we assumed that the time of Guti rule centered about the year 2100 B.C.". See, van der Meer, 1954 : 48, who gives 2122-2025.

50. Henning, *op, cit.*, 219 .

51. *Ibid.*, 220-221.

52. *Ibid.*, 224.

53. Crossland, 1971 : 824, "But most of those who came from the north and who are identified for the first time after 2000 B.C. spoke languages which belong to the Indo-European family."

54. According to Gadd, 1971 : Naram-sin reigned from 2291-2255 B.C.

55. Ungnad, 1936 : 151 n. 5.

56. Henning, *op. cit*, 219. He notes that "there is no actual evidence in favour of such a hypothesis. On the other hand Ungnad states doubts if the language of the Guti was "Kaukasussprache" and finds the supposition that they were "blond" unacceptable. (*op. cit.*, 151 n. 5).

57. See *supra*, n. 38. While Henning rejects the story of Lugal-anni-mundu and his conquests, which included the Gutium, he appears to accept the story of Autaluma and Kiklipatalli.

58. See *supra*, p. 3.

59. Henning, *op, cit.*, 218.

60. *Ibid.*, 220. Even if we ignore Sargon's relevance and count from the time of Naram-sin (2291-2255 B.C.; Seton Lloyd states that he came to the throne about 2260 B.C., 1977 : 71; Joan Oates, 1979 : 199, gives 2254-2218 for his reign) to that of Hammurapi (1791-175) according to Oates, 1979 : 61) we are talking of five centuries.

61. Henning, *op. cit.*, p. 215.

62. Henning has not provided any evidence for this. He assumes that they followed the path taken by the Kimmerians and Scythians later because "such tribal movements are apt to take the same direction and follow the same routes, it is probable that the Guti, too, had come from Southern Russia through the Pass of Derbend" (p. 219). Besides, it is doubtful that even the Kimmerians and Scythians lived originally in Southern Russia.

63. Ungnad (1948 : 151).

64. Pulleyblank (1966 : 15).

65. Gimbutas (1963 : 815-836).

66. Gimbutas ibid

67. Sulimirski (1970 : 244-316).

68. Jettmar (1951 : 135-223 ; 1950-54 : 236-254).

69. Pulleyblank (1966 : 35). "The linguistic position of Tocharian within Indo-European makes it probable that its speakers *always* lay to the east of the Indo-Iranians." (Italics mine).

70, Haloun (1937 : 317).

71. Chlenova (1964 :) ex Sulimirski (1970 : 308).

72. Anderson (1943 : 222) ; Chang (1977 : 193-199 ; 397-409).

73. Pulleyblank (1966 : 29).

74. Prusek (1971 ; 72) who states that "there was probably no Indo-European invasion on the western frontiers of China in the early years of the first millennium B.C. causing the barbarians to migrate either to the west or to the northewest, for the single reason that the Indo-Europeans had been there since time immemorial."

75. Chang (1977 : 195-199). Prof. Chang informs me (personal communication) that he is now preparing another revised edition of his book, but in that too, his position in regard to the Qijia culture and its relationship with others remains essentially the same : I am thankful to him for reading my draft and for his comments.

76. *Ibid.*, 198-199.

77. Watson (1983 : 537-546). He points out the close similarity between "the Pottery kiln of the Yang-shao neolithic culture of central China and the kiln used at Tepe Sialk in Central Iran during the later 4th millennium B.C." It is not clear why he assumes "the Yangshao painted pottery itself constitutes the easternmost region reached by a tradition of ceramic ornament which *spread from* the Iranian plateau." Why not the other way round, particularly when he admits that "in the case of China this diffusion was not accompanied by the transfer of any cultural system." One may appreciate his statement made later that "on the whole the archaeological records tell against attempts to identify groups of artefacts strictly with ethnic groups, and one must conclude that ideas could move through the Scythic one independently of large-scale tribal migration."

Also, it may be noted that evidence of trade between China and Scandinavia in early first millennium B.C. has been found in the form of goods of Chinese origin in Svartarp in Vastergotland (Sulimirski 1970 : 334) but nothing of western origin in China during that period which indicates one way movement from the east to the west,

78. If the Qijia farming traditions were introduced from the Yangshao culture the latter also were probably among the "first" Indo-Europeans of *Centum* group, although it is difficult to identify their species of language. Linguists may look for survival of archaic forms in Tokharian as distinguished from common forms.

79. Pulleyblank (1966 : 30).

80. It is interesting to note such titles of publications as *Prehistory of Czekoslovakia, Five Thousand Years of Pakistan* to which one may add *Alexander the Great of Yugoslavia.*

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The Potential of Annular Analysis for South Asian Archaeology

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This paper describes the examination of microscopic thin sections of teeth from Indian domestic animals. Thin sections display annual growth increments that can be used in archaeology to age faunal remains, or more importantly to fix the season of death of fauna, hence to provide indications of seasonal habitation. Domestic herd animals are examined in order to show that the technique is viable for the study of ancient pastoral nomadism. This report is in the nature of a feasibility study ; therefore results of modern animals are discussed. The results can, however, be extrapolated to cover archaeological fauna.

INTRODUCTION

Teeth, like trees, exhibit annual growth rings. Growth rings can be found in the teeth of most mammals, in a substance surrounding the tooth root that is known as cementum. Growth rings in tooth cementum comprise two components, one light and the other dark in color. In most mammals one pair of these increments forms each year, hence cemental growth rings are known as annual rings or annuli (sing : annulus). When annuli in a tooth are counted, they reveal the age of the animal. In addition, light and dark increments form at opposite seasons throughout an animal's life. The last increment on an archaeological tooth, which was in the process of formation when the animal died, will reveal the season of death of the individual concerned.

These properties of annual rings are very attractive to archaeologists interested in ancient pastoral migration. Archaeological evidence of temporary, seasonal occupation is inherently uncertain, and the influence of sedentism or nomadism does not normally place a unique stamp upon the character of a settlement. Therefore it is very difficult to prove that a particular archaeological site was occupied during part of the year only, and it is even more difficult to determine in which part of the year occupation took place. Annular analysis can make seasonal determination a more accurate task, especially where migrating herds are concerned. This point becomes evident when other methods of seasonal determination are examined.

PROBLEMS OF SEASONAL DETERMINATION

If one wishes to understand pastoral economy in the archaeological record, it is critical to have information about mobility and the seasonal rhythm by which mobility is structured. This information is hard to come by from standard indicators, which can be divided into features found at sites, characteristics of site location, and biological remains. Each category exhibits its own particular set of disadvantages.

Certain site features, such as evidence of impermanent shelters and animal enclosures, and the absence of other features, such as major improvements to property, have traditionally been accepted as indicators of seasonal occupation (Hole 1980 : 122 ; Chang and Koster 1986 : 112-115). These criteria suffer from a reliance upon negative evidence : when permanent architecture and site improvements have been destroyed by erosion or other disturbances, a sedentary settlement may be mistaken for a temporary one. Impermanent structures themselves tend to be poorly preserved at archaeological sites. Moreover, even if these criteria can roughly distinguish between temporary and permanent occupations, they alone cannot indicate the particular season in which a settlement was inhabited, nor the total portion of the year during which it was populated. These criteria are therefore useful if only the vaguest of judgements is required.

A more useful criterion is site location, either one that is some distance from arable land, or close to seasonal pasture or traditional migratory routes (Shaffer 1978 : 119 : Hole 1980 : 122). The territorial approach can sometimes pinpoint season of occupation when summer and winter pastures are distinct (Barker 1975 : 157), but it is best suited to heterogeneous topography such as mountainous areas. Furthermore, an approach that relies on a simple relationship between landscape and land use is overly deterministic. Many populations are known to have shifted between nomadism and sedentism without changing their territorial focus (e.g. the Arabian Bedouin ; Vignet-Zunz 1979). Thus a territorial approach is of limited use in determining temporary, seasonal occupation.

Biological indicators, such as the bones of migratory birds, remains of commensal rodents (Hesse 1982 : Tchernov 1984), and mollusc shells which preserve growth increments (Monks 1981) have often been utilized to fix season of occupation. Unfortunately, while these may constitute accurate measures of human occupation, they do not measure the migration of animal herds. One of the salient characteristics of the pastoral mobility is that it need not involve the entire human population. When herd migrate, they often do so under the care of a group of herdsmen, while segments of the human population such as the elderly, infants, and perhaps females remain behind. Pastoralist settlements may thus have some year-round residents, but it would be a mistake to infer from this that pastoral migration was not taking place. If one wishes to study pastoral migration, one must measure the movement of the herds themselves. One cannot rely on indicators that chart human seasonality alone.

One direct measure of herd seasonality has received wide application—the determination of age at death from tooth eruption and wear patterns in mandibular remains, and thence derivation of season of death by reference to a restricted birth period (Higgs and White 1963 : Bokonyi 1972). For example, if sheep remains show that for a high proportion of individuals the lower first molar was erupting when death occurred, then many deaths at the age of about six months may be assumed. If sheep are known to be born in the spring, then it may be further assumed that sheep occupied a particular settlement in the fall (at the least). This technique suffers from poor reliability however, because eruption times in archaeological fauna are unknown and must be guessed from modern (or several centuries old) data. But rates of growth and development in domesticated herd animals have varied widely according to breed and management conditions, thus ages of tooth eruption have changed significantly, but in an uncertain fashion, over time (Silver 1970 : 295-299). Aging animal remains to three or six month intervals is highly inaccurate when the ages at which teeth erupt in thousand year old specimens must be guessed from modern representatives.

A MORE APPROPRIATE METHODOLOGY

The analysis of annual rings, or annuli in the teeth of archaeological faunal remains, can accurately fix season of death of fauna at pastoral sites, indicating the time of year that herds were quartered in a settlement. Such analysis is a direct measure of herd seasonality but does not share the disadvantages associated with tooth eruption sequences. This technique is relatively new, having been applied to archaeological determinations of seasonality only since 1974. It has been attempted on Indian fauna experimentally and seems to hold great promise for the future. As it is not a technique that is well-known to the archaeological community at large, a brief description of the method follows.

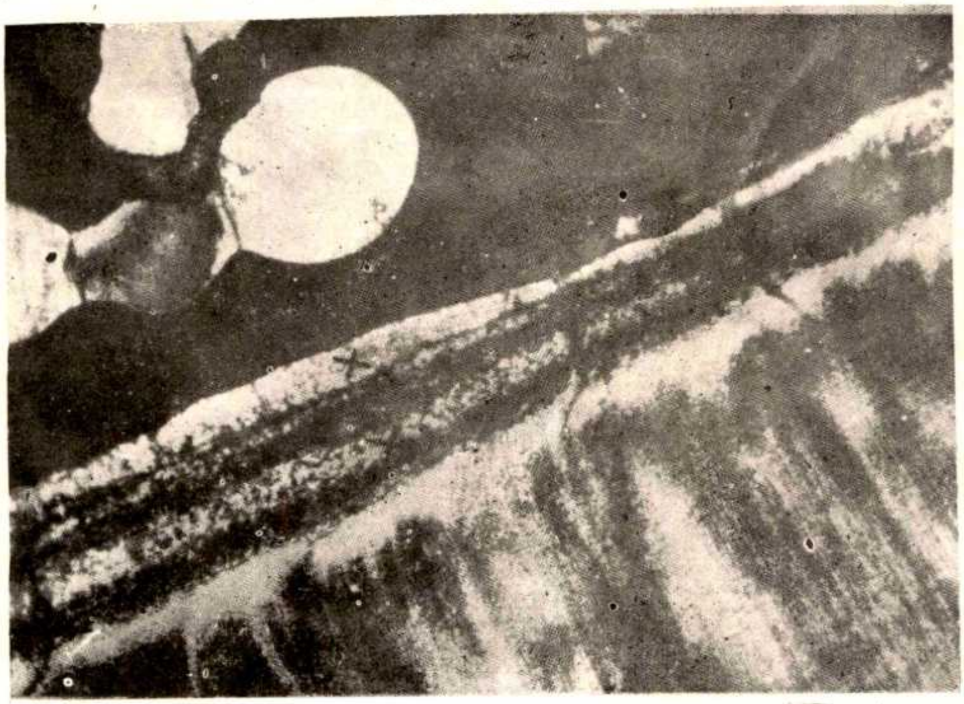

Plate I. Buffalo killed in February.
X : Growth zone
P^3 Magnifies 44 Times

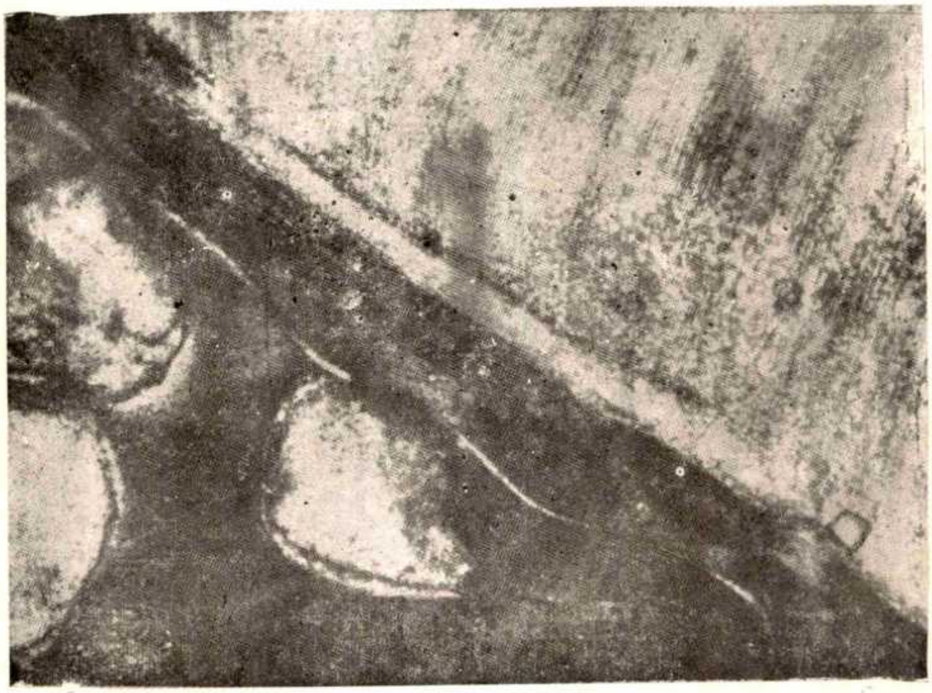

Plate II. Buffalo Killed in July
X : Growth zone
P^3 Magnified 56 Times

This technique assesses microscopic annuli in a dental substance known as cementum. Cementum is a mineralized collagen, structurally analogous to bone, which coats the roots of the teeth in all mammals. It is formed continuously over the life of the tooth. The substance is created when cells called cementoblasts deposit collagen around their membranes (Ramfjord and Ash 1979 : 49), and then infuse this fibrous matrix with crystals of hydroxyapatite (Selvig 1965 : 423). Annuli in cementum are observable under magnification as narrow, usually dark (depending on the method of observation), highly calcified bands. While there is no well-accepted explanation for their physiological origin, current opinion suggests that they arise from periodic variations in build-up of the collagen matrix. Klevezal and Kleinenberg (1969 : 22) suggest that a constant rate of calcification, combined with periodically slowed growth of collagen, will generate the narrow yet calcium rich increment. But whether or not it is controlled by the metabolysis of protein, the formation of annuli does seem to reflect the seasonally slowed growth rate of the organism.

Since the 1950s a large number of studies have correlated the pattern of incremental lines with annual periodicities. It was discovered that among temperate zone terrestrial mammals one narrow, dark line formed in the late fall, winter, or early spring, while during the warmer months a broad, lighter band was deposited (Sargeant and Pimlott 1959 : Mitchell 1963 ; Mundy and Fuller 1964 ; Novakowski 1965). The narrow band, arising from slowed growth, will be herein termed a rest line ; the broad band will be referred to as the growth zone. By counting the number of rest lines, an estimate could be derived of the number of winters an animal had survived, hence its absolute age. In this way wildlife biologists have extensively examined the age structures of temperate zone seal, whale, ungulate carnivore, insectivore, and rodent populations.

Compared to this abundance of data, research on the dental annuli of tropical and sub-tropical animals has been sparse. Primarily a variety of East and South African bovids (Spinage 1967 ; Simpson and Elder 1969 ; Rautenbach 1971 ; Robinette and Archer 1971 ; Grimsdell 1973 ; Simpson 1983 ; Spinage 1976) and carnivores (Lombaard 1971 ; Smuts, Anderson and Austin 1978) have been examined. Tropical animals may form one or two rest lines per year, a pattern that is correlated with the number of dry seasons per annum in their home range. In the tropics it appears that annual rings reflect seasonal variations in moisture rather than winter weather.

Still more obscure are the annular studies of domestic animal and man. Stott, Sis and Levy (1982) met with success in aging three human cadavers from their cemental annuli, claiming a high degree of accuracy. Grue and Jensen (1979 : 37) also observed incremental lines in human teeth, but it was not possible to isolate primary lines from secondary laminations and consequently no age determination was possible. Similarly, it was concluded that annuli could not be correlated with seasonal cycles in Danish dogs kept as house pets (Grue 1976 : 4). On the other hand, domestic sheep from New Zealand, and Danish dairy cows and pigs were successfully aged, despite the provision of fodder throughout the year and sheltering during the winter (Saxon and Higham 1968, 1969 ; Rudge 1976 ; Grue and Jensen 1979 : 37).

ARCHAEOLOGICAL APPLICATIONS

Archaeologists developed an interest in annular analysis beginning in the late 'sixties (Saxon and Higham 1968, 1969), and broadened the scope of inquiry to include season of death as well. The first seasonal determinations were published by Benn (1974) and Kay (1974), both using white-tailed deer from Woodland sites in the Midwest. In the last ten years additional seasonal and aging studies have been carried out on archaeological remains of several species of seal (Spiess 1976, 1978 ; Fletemeyer 1977 ; Morrison 1983), caribou (Spiess 1979 : 148, 191 ; Gordon 1982), musk ox (Savelle and Beattie 1982), and cattle (Coy, Jones and Turner 1982). This body of research has shown that annular analysis is a viable technique for both age determination and estimating season of death of archaeological fauna.

Season of death of an individual animal is assessed by examining the outer edge of the cementum deposit, the layer in formation at the time the animal died. If the outer layer was a rest line, death during the winter (or dry season) would be indicated. A growth zone at the outer edge of the tooth would imply that death occurred in late spring, summer, or early fall (or the rainy season). Greater accuracy has been claimed (Spiess 1976 ; Savelle and Beattie 1982 : 125 ; Gordon in press), based on a comparison of the width of the outer layer, either rest line or growth zone, with the widths of the analogous inner layers. For example, an outer growth zone that is half the width of the inner zones might suggest that the individual represented died mid-way through its growth seasons, or in mid-summer for a temperate zone animal. An outer growth zone as wide as the inner zones would indicate death after a completed growth season, perhaps in the autumn.

When the seasonal data for each tooth are aggregated, the result is a slaughter schedule that indicates the relative proportions of the fauna that died in each part of the year. The schedule is then analyzed for clustering and gaps in season of death. A uniform pattern would indicate slaughter throughout the year. A sharp concentration of slaughter times, in the absence of evidence for death at other times of the year, would instead point to a marked seasonality in killing with further consequences for pastoral organization.

THE NEED FOR A CONTROL POPULATION

One drawback to annular analysis, evident from this account, is the conclusion that incremental lines form in cementum under a variety of external and internal stimuli. While temperate zone animals form lines in winter, tropical animals form lines in dry seasons ; apparently temperature and day length are involved only indirectly. More obvious is the influence of nutritional stress, but annuli have been observed as well in domesticates that are fed and sheltered year-round, and in humans who were presumably not exposed to seasonal stress at all. The formation of annuli seems to be controlled by an interactive combination of climate, nutrition, and hormonal balances which are not fully understood.

Such lack of understanding is reinforced by exceptions to the normal annular pattern among certain species. For example, several temperate carnivores, including foxes and wild felines, form rest lines in the summer instead of winter (Grue and Jensen 1979 : 12-14). In the tropics, Simpson and Elder (1969) observed two rest lines per year in the greater kudu although its habitat in southwestern Zimbabwe exhibits one annual dry season. These exceptions form the minority of observations but illustrate that there is no hard and fast relationship between environment and the timing of rest line formation. This represents the major obstacle in current attempts to correlate archaeological annular patterns with season of death.

The research presented here attempts to resolve the problem for Indian archaeological fauna. The most generally accepted solution involves an empirical study of modern representatives of the archaeological species in question. The seasons at which rest lines formed in archaeological animals can never be known, but can be assumed to be similar to modern descendants of the same species who occupy the same habitat. In the absence of environmental change, it is safe to assume that seasonal growth patterns have remained roughly the same over time. Thus, if one wishes to study archaeological animals in India, it is necessary to study a control sample of modern counterparts. If one is interested in nomadic pastoralism, then one must study modern cattle, buffaloes, sheep, and goats from a similar environment as that postulated for the archaeological context. This paper describes such a study of modern Indian domesticates, in the hope that future archaeological research may utilize these data.

SAMPLE SELECTION AND PREPARATION

The archaeological material for which seasonal information was desired was excavated from the site of Oriyo Timbo in Bhavnagar District, Saurashtra. This site was tested in 1981/1982 by a combined team from the Gujarat Department of Archaeology and the University Museum, Philadelphia, USA. The final report is in preparation. Oriyo was posited to be a temporary pastoral camp on the basis of thin cultural deposit, lack of solid architecture, and abundance of cattle bones, along with fewer specimens of sheep, goat, and pig. The site dates from the Rangpur III period, which in overall climate resembled the conditions of Gujarat today (cf. Ghosh and Lal 1963 ; Seth 1978 ; Singh et al. 1974) Therefore modern samples of *Bos*, *Ovis*, *Capra*, and *Sus* from Saurashtra formed the ideal sample population for a control study.

Certain limits to data collection precluded a perfect match of species and habitat, however. Given local sensitivity to the cow it was neither wise nor practical for the control sample to utilize the dental remains of *Bos indicus*. Therefore the mandibles of water buffalo (*Bubalus bubalis*), a closely related member of the tribe of Bovini, were substituted for those of zebu cattle in the control study. Other herd animals were easily available, so that a sample of sheep and goat teeth was also acquired. A number of pig mandibles were collected to complete the range of domestic ungulates typical of Western India.

Habitat was also imperfectly matched to the ancient sample but in an insignificant fashion. While some of the control specimens were collected in Gujarat, practical constraints necessitated that most of the sample of modern teeth come from the area around Delhi. Environmental differences between Delhi and Gujarat include marginally more precipitation in the capital during the monsoon and in winter as well, somewhat colder winters, and a more variable length of day The pattern of seasonality however, with monsoonal rains from June to September, a warm dry period until November, cool weather from December to February, and hot dry weather from March to early June, is identical in both places. It was therefore expected that the pattern of annulus formation would not vary between the two regions, and indeed this has been confirmed by analysis.

Along with species collected and locality of collection, the date and age of death were recorded. The teeth of freshly killed animals were gathered during the months of November, February, and July. Age at death was estimated from the tooth eruption tables provided by Silver (1970) for sheep, goat, and pig, and from MacGregor (1939 ; cited in Grimsdell 1971 : 37) for water buffalo. One sheep specimen in the advanced adult stage was aged by tooth wear according to the scheme of Payne (1973 : 293). In all, 15 animals, consisting of six buffalo, three pigs, four goats, and two sheep were examined for annuli. If this range of species agreed in the season of rest line formation, confidence would increase that *Bos indicus* follows a general Western Indian domestic ungulate or bovid pattern.

Annuli in this study were examined in dental thin sections, observed with polarized light using a a petrographic microscope, a standard procedure for archaeological specimens (Morris 1972). Sections were prepared in the following manner : conjoined teeth were sawn apart with a hacksaw, leaving the jawbone intact around the roots. Individual teeth were then impregnated with epoxy. Teeth were sectioned longitudinally along the lingual-buccal plane with a Buehler Isomet slow-speed rotary saw and the sawn face was glued to a glass slide. The tooth was sawn a second time on the Isomet, parallel to the slide and as close to the face of the slide as possible. The specimen was then ground on a wheel and finally by hand on a glass plate until a thickness of 35-40 microns was attained.

Slides were observed using a Vickers petrographic microscope under magnifications of 50 to 100x. For each tooth the number of rest lines was recorded as well as the character of the outermost band. The latter variable was recorded in one of four ways. When the outermost layer of cementum was a rest line, a death in the season of slowed growth was noted. Second was the case in which a rest line was outermost but traces of a growth zone could be seen forming on portions of the root. This instance was marked as a death during the seasonal transition from slowed growth to the beginning of normal metabolysis. Third and fourth were instances in which the growth zone was the outermost layer of cementum. This zone was distinguished as being in its early or late phase of apposition by comparison of the outer and inner growth zones. If the outer growth zone was one half or less the widths of the inner zones, a death in the early part of the growth season was recorded. If the outer growth zone was greater than half the widths of the inner zones, a death in the latter part of the growth season was noted.

ANNULAR RESULTS OF THE MODERN SAMPLE

The incremental pattern as recorded from modern animals of known age and season of death clearly suggests that rest lines form under seasonal influcnce in Western India (Table 1). Of the seven animals killed in November or February, all had a majority of teeth with nearly completed growth zones at the outer edge of the cementum (Plate I). Of a total of 37 sections from seven animals, 32 agreed with this pattern. In these Western Indian animals, the months of November through early February fall into latter portion of the growth season.

TABLE 1

ANNULAR RESULTS OF THE MODERN SAMPLE

	Species	*Age in Months*	*Date of Death*	*Tooth*	*Rest Line*	*Annular Death Season*
1.	buffalo	34-40	2/1/84	P3	2-3	late growth
			Rajkot	M1/M2	3	late growth
				P3	3	late growth
2.	buffalo	15-18	2/1/84	P3	2-3	late growth
			Rajkot	P3	1-2	late growth
				P3	2-4	early growth
				P4	3	late growth
				P4	2	late growth
				P4	1-2	late growth
				P4	1-2	late growth
3.	goat	19-25	2/1/84	P3	0-1	late growth
			Rajkot	M1	2	early growth
				M1	1	late growth
				M1	1	late growth
				M2	1	late growth
4.	buffalo	>48	11/29/83	P4	3	early growth
			Delhi	P4	2	late growth
				P4	3	late growth
				P4	2	late growth
				M1	4-5	late growth
				M1	2	late growth
				M1	2-3	late growth
5.	pig	13-17	11/29/83	P4	1	late growth
			Delhi	M1	2	early growth
				M1	2	late growth
				M2	2	late growth
				M2	1-2	late growth
6.	sheep	72-96	11/29/83	P4	4	late growth
			Delhi	M2	4	late growth
				M2	3-4	late growth
				M3	3-4	late growth
				M3	2-3	late growth

	Species	*Age in Months*	*Date of Death*	*Tooth*	*Rest Line*	*Annular Death Season*
7.	sheep	18-24	11/29/83 Delhi	P4	2	rest
				M1	1	late growth
8.	buffalo	17-20	7/84 Delhi	P2	2	early growth
				P3	3	early growth
				P4	2	early growth
				M1	2	early growth
9.	buffalo	17-20	7/84 Delhi	P3	2	early growth
				P4	2	rest/early growth
				M1	1	early growth
10.	buffalo	15-18	7/84 Delhi	P2	2	early growth
				P3	2-3	late growth
				P4	2	early growth
11.	pig	17-22	7/84 Delhi	P4	2	early growth
				M1	2	early growth
				M2	1-2	early growth
12.	pig	17-22	7/84 Delhi	P2	1	late growth
				P4	2	early growth
				M1	1	early growth
				M2	1-2	late growth
13.	goat	18-24	7/84 Delhi	P4	1	rest/early growth
				M1	1	early growth
14.	goat	7-9	7/84 Delhi	P3	2	early growth
				M1	0-1	?
15.	goat	6-7	7/84 Delhi	P2	2	early growth
				P3	1	late growth
				P4	1-2	rest/early growth

The animals killed in July are opposite in their indications. Of 24 teeth from eight animals, 19 had the beginning of a growth zone forming at the outer edge of the cementum (Plate II). This strongly implies that the month of July falls within the early portion of the Western Indian growth season.

If July marks the beginning of the growth season, and February falls in the late growth season, the time of year during which rest lines are formed can be bracketed sometime within the months of February to July. This result is very satisfactory in light of our knowledge of bovine physiology as it is affected by the Western India climate. A definite 'comfort range' exists for tropical cattle that is related to air temperature. As the thermometer climbs above 27 C. (80 F), homeostatic mechanisms of cattle are activated, causing respiration and vaporization rates to increase (Williamson and Payne 1968 : 10). When the temperature rises above 35 C. (95 F), these mechanisms begin to fail ; as a result rectal temperatures rise, food intake declines, *metabolic processes such as milk production and growth slow down*, and a loss in body weight may occur. Studies suggest that similar connections might be found for pigs, and possibly for sheep (Williamson and Payne 1968 : 10-11). In Gujarat and most of Western India mean maximum temperatures rise above 35 C. in the months of March or April, and remain above this threshold until mid-June (Government of India 1964). The annular results agree perfectly with this climatic cycle.

Nutritional stresses are also at a maximum at this time. In Western India precipitation is most heavy from late June to mid-September. Between September and June, rainfail is extremely scarce. As the dry season progresses, water sources diminish and vegetation grows brown. The most difficult part of the dry season is just before the rains begin again ; at that time, with moisture resources at a yearly minimum, the temperature climbs to its yearly maximum, and through increases in evapotranspiration adds significantly to the loss of water. During these months, when moisture and pasture quality are both at their lowest point of the year, nutritional stress would be expected at its greatest level.

As animals killed during the months of March, April, May and June were not included in the sample, the precise times between early February and mid-July when the apposition of rest lines starts and stops cannot be further detailed. Based on these results, it is probably safe to assume that archaeological animals with outer rest lines were slaughtered in the four months period from March through June, while animals with growth zones outermost were killed between July and March. This study demonstrates that the application of annular techniques to Indian fauna is feasible, and that the potential exists to extend the method to ancient remains as well.

RESEARCH ON ARCHAEOLOGICAL FAUNA

This research was used to calibrate annular patterns of cattle, sheep, and goat teeth from Oriyo Timbo in an investigation of seasonal mobility (Rissman 1985). It was determined that deaths of herd animals were strongly clustered in the months of March to July, with little evidence of deaths at other times of the year. These findings reinforced the hypothesis that Oriyo was a pastoral camp temporarily occupied during the dry season.

I invite other researches to utilize these data in order to determine season of death for their own faunal assemblages. In addition, it is desirable for future studies to include modern specimens, to confirm or refute the present results. If it is confirmed that rest lines form in modern Indian domesticates during the hot season then further calibrations will be unnecessary. At that point archaeologists can concentrate on ancient remains.

Seasonal herd mobility is an important subsistence strategy today in several parts of India, and was presumably so in the past. Seasonal mobility is difficult to identify in the archaeological record, however. Annular analysis can help in this issue. It is hoped that annular analysis will be attempted in the future by South Asian scholars, and that the results of this research may aid in such an undertaking.

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The Developmental Stages of Blade Tool Industries of South Uttar Pradesh from the Upper Palaeolithic to the Mesolithic

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Since 1966-67 onwards, the archaeologists of Allahabad University discovered a large number of Upper Palaeolithic and Mesolithic sites in the area of South Uttar Pradesh (which includes the districts of Varanasi, Pratapgarh, Banda, Allahabad, Mirzapur) specially in the Ganga Valley, Belan Valley, Son Valley and Kaimur regions. They had located nearly 79 sites in the Belan Valley, 200 sites in the Ganga Valley, 120 sites in the Son Valley and 123 sites in the Kaimur region (Verma : 1980). Large number of materials had been collected from these sites. As these materials are all surface collected materials, in the absence of any stratigraphical evidence, on the basis of typology they have been divided into two broad groups belonging to two periods.

(1) Upper Palaeolithic Period
(2) Mesolithic Period.

Since all the collections were from surface sites here, the problem arises—is there any developmental sequence between these two periods or is there any correlation between these surface sites with one another ?

To solve such problems only 10 representative sites were chosen for sample surveying. A detailed study of the collected materials of these ten sites were made—

(1) Mitapur (in District Mirzapur)
(2) Pataudh (-do-)
(3) Bakhraur (-do-)
(4) Khuntabir (-do-)
(5) Piari (In District Allahabad)
(6) Lohanda Nala (In District Allahabad)
(7) Murwa (-do-)
(8) Baghai Khor (in District Mirzapur)
(9) Lekhahia (-do-)
(10) Sarai Nahar Rai (in District Pratapgarh)

Out of these 10 sites the first 7 sites represent the so called Upper Palaeolithic period and the remaining three sites represent the Mesolithic period.

The typological and statistical analysis of these 10 sites rewarded an extra-ordinary result regarding the developmental sequence of the Lithic Industries of this area from the Upper Palaeolithic to the Mesolithic which has been observed for the first time in Indian Prehistoric context. On the basis of this study three developmental stages have been noticed through which the Upper Palaeolithic Industry evolved, flourished and transformed into the microliths of the Mesolithic period. Present

TABLE I

MATERIALS ANALYSIS OF THE ARTIFACTS OF THE TEN REPRESENTATIVE SITES

Name of the sites	Total collection	Raw Material (%)					Simple flake & fragments %	Unmodified waste %	Core %		Unretouched Blade %	Finished Products %
		Chert	Silt stone	Jasper	Chalcedony	Agate			Fluted Core	Flake core		
MITAPUR (MTP) (83°—24°35′)	926	71	14.7	6.3	6.5	—	53.9	9.7	57.4	42.6	6.6	13.1
PATAUDH (PDH) (83°5′—24°32′)	1015	82.3	9.8	4.1	1.8	—	41.5	6.6	68.6	31.4	4.4	15.7
BAKHRAUR (BKR) (83°4′—24°31′)	1118	79.8	11.4	2.5	2.2	—	56.7	9.14	63.9	38.1	8.05	10.0
PIARI (PRI) (82°2′—25°52′)	1272	72.6	11.6	6.2	5.3	1.6	54.9	7.6	77.3	22.7	5.3	9.27
LOHANDA NALA (LHD) (82°5′—24°56′)	1985	61.5	5	14.1	14.2	2.5	52.6	13.6	72.1	27.9	4.9	9.97
MURWA (MRW) (82°5′—24°55′)	1700	85.1	2.1	1.7	10.8	0.2	46.2	17.5	73.3	20.1	14	10.2
KHUNTABIR (KTB) (82°15′—24°50′)	5871	64.8	2.1	5.1	27.5	—	50.3	14.2	70	30	6.2	7.4
BAGHAIKHOR (BGK) (24°48′—82°6′)	14,957	57	1.9	9.9	28.2	1.7	54.3	27.3	52.6	47.4	5.5	4.9
SARAI NAHAR RAI (SRN) (81°51′—26°48′)	6312	9.4	—	26.8	62.0	1.2	66.6	11.3	50.1	49.9	0.4	10.5
LEKHAHIA (LKH) (82°8′—24°47′)	11,473	37.4	0.7	9.5	45.4	5.1	56.5	16.7	79.3	20.7	9.5	14

TABLE 2

COMPARATIVE STATEMENT OF THE BLADE TOOLS (%)

Name of the Sites	*Lunate*	*Trapeze*	*Triangle*	*Convex Backed Blade*	*Concave Backed Blade*	*Straight Backed Blade*	*Partially Backed Blade*	*Double Backed Blade*	*Concave Convex Backed Blade*	*Pointed Backed Blade*	*Retouched Blade*	*Double Retouched Blade*	*Partially Retouched Blade*	*Retouched and Backed Blade*	*Truncated Blade*	*Backed and Truncated Blade*	*Retouched and Truncated Blade*	*Notched Blade*	*Backed and Notched Blade*	*Retouched and Notched Blade*	*Notched and Truncated Blade*	*Denticulated Blade*	*Notched and Denticulated Blade*
MITAPUR	—	—	—	1.6	—	—	—	—	—	—	3.3	—	3.3	—	—	—	—	5.8	—	0.8	—	—	—
PATAUDH	1.3	—	—	1.9	—	0.6	2.5	—	—	—	3.8	1.9	1.9	—	—	—	—	4.4	0.6	1.3	—	0.6	—
BAKRAUR	1.8	—	0.9	1.8	0.9	0 9	2.7	—	0.9	—	4.5	0.9	1 8	0.9	1.8	—	—	1.8	—	—	—	1.8	.9
PIARI	4.3	—	—	8.5	2.5	5.1	3.4	1.7	1.7	—	4.2	1 7	3.4	2.5	—	—	—	3.4	0.8	—	—	—	—
LOHANDA NALA	14.6	0.5	—	11.6	2.0	1.0	4.5	1.5	—	2.0	3.0	1	4.5	0.5	2.5	1.0	0.5	3	—	0.5	0.5	1	—
MURWA	4	0.6	1.7	9.2	2.3	4	7.5	0.6	—	1.2	5.1	2.3	2.9	2.3	1.2	5.1	—	5.7	—	0.6	—	—	—
KHUNTABIR	1.8	0.2	0.7	3.2	1.6	8.1	3.9	1.5	—	2.2	7.4	5.8	0.7	1.8	1.6	1.6	—	7.2	0.9	1 6	0.5	0.9	—
BAGHAI KHOR SARAI	13.5	0.8	3.0	18.5	4.5	16.1	4.1	1.2	1.1	8.0	11.6	4.1	1.2	1.1	2.9	3.6	0.6	0.4	0.3	0.1	—	—	—
NAHAR RAI	6.8	1.8	0.4	3.0	9.5	1.0	4.1	6.5	0.8	5.1	3.0	0.6	0.8	0.4	2.6	4.8	0.1	1.2	0.3	0.1	0.1	—	—
LEKHAHIA	8.7	2.0	6.5	5.2	1.9	7.8	5.1	0.2	—	8.6	9.1	2.8	2.7	0.9	6.2	7.8	0.3	0.4	0.2	0 1	—	—	—

paper deals only with the developmental stages of blade tool industries of this area.

The analysis of these 10 sites (as is evident in the Table 1 and 2) clearly suggests that though they are mainly dominated by simple flakes and fragments which only suggest that some of these sites were factory sites ; but so far as the finished products are concerned, these assemblages are undoubtedly characterized by the presence of various types of blades and blade tools.

Three developmental stages have been noticed from the Upper Palaeolithic to the Mesolithic periods—

Stage—I : is represented by the sites Mitapur, Pataudh and Bakhraur. The average mean value of the length/breadth/thickness of the artifacts and the unretouched blades of this stage are 3.3/2.2/0.7/ and the average breadth/length and thickness/breadth ratios are—0.67 and 0.34.

Stage—II : is represented by the sites of Piari, Lohanda-Nala, Murwa and Khuntabir. The average mean value of the length/breadth/thickness of the artifacts and unretouched blades are—2.6/1.4/0.5 and the breadth/length and thickness/breadth ratios are—0.54 and 0.35.

Stage—III : is represented by the sites Baghaikhor, Sarai-Nahar-Rai and Lekhahia. The average mean value of the Length/breadth/thickness of the finished products and unretouched blades are 1.65/0.6/0.22 and the breadth/length and thickness/breadth ratios are 0.4 and 0.35.

The statistical analysis of the blade tools of these three stages present very remarkable development sequences.

TABLE 3

COMPARATIVE STATEMENT TABLE OF THE ARTIFACTS PREPARED ON BLADE AND FLAKES

	Name of the sites	*Artifacts made on blade* %	*Artifacts made on flakes* %
St-I	Mitapur	52.9	47.1
	Pataudh	54.1	45.9
	Bakhraur	63.4	36.6
St-II	Piari	72.9	27.1
	Lohanda Nala	83.3	16.7
	Murwa	81.3	18.7
	Khuntabir	85	15
St-III	Baghaikor	98.5	1.5
	Sarai Nahar Rai	96.1	3.9
	Lekhahia	98.3	1.7

TABLE 4

COMPARATIVE STATEMENT OF CORES

	Name of the site	*Fluted Cores* %	*Flake Cores* %
I	Mitapur	57.4	42.6
	Pataudh	68.6	31.4
	Bakhraur	63.9	38.41
II	Piari	77.3	22.7
	Lohanda Nala	72.1	27.9
	Murwa	73.3	20.1
	Khuntabir	70	30
III	Baghaikhor	52.6	47.4
	Sarai Nahar Rai	50.1	49.9
	Lekhahia	79.3	20.7

(1) The blade industry, as Tables No. 3 and 4 reveal (Fig. 1, 2) was evolved in the first stage as 50% or more artifacts are prepared on blades and in the total collection of cores nearly 60% present fluted cores. In the stage-II 80% artifacts are prepared on blades and 70% presented fluted cores and in stage III 98% artifacts have been prepared on blades.

TABLE 5

COMPARATIVE STATEMENT OF THE MEAN VALUE OF THE LENGTH/BREADTH/THICKNESS AND THE RATIOS OF BREADTH/LENGTH AND THICKNESS/BREADTH OF THE ARTIFACTS AND UNRETOUCHED BLADES

	Name of the sites	*Mean*			*Ratio*	
		L	*B*	*Th*	*B/L*	*Th/B*
I	MTP	3.3	2.2	0.75	0.67	0.34
	PTD	3.2	2.3	0.82	0.71	0.36
	BKR	3.5	2.2	0.71	0.65	0.31
II	PRI	3.2	1.7	0.63	0.55	0.36
	LHD	2.4	1.3	0.46	0.56	0.34
	MRW	2.7	1.4	0.52	0.51	0.36
	KTB	2.3	1.3	0.46	0.56	0.35
III	BGK	1.7	0.6	0.24	0.4	0.5
	SRN	1	0.6	0.3	0.6	0.5
	LKH	1.6	0.7	0.23	0.4	0.35

(2) So far the workmanship of the blade manufacturing is concerned, the gradual reduction in the mean value of the length/breadth/thickness of the artifacts prepared on blades and the unretouched blades (as shown in Table No. 5) indicates the refinement in blade production. If we consider the ratio of the reduction of the breadth/length of these artifacts we find that in the first stage the breadth of the blades is more than half of the length (0.67). In stage II the breadth becomes half the length (0.5) and in stage-III it becomes less than half the length. The thickness of the blades is reduced in high proportion, which indicates the refinements in the blade production. It is also important to note that with the decrease in the length of the blades the length of the fluted cores also decreases.

(3) A careful study of the cores also present different stages of manufacture of the blades. As the blades of

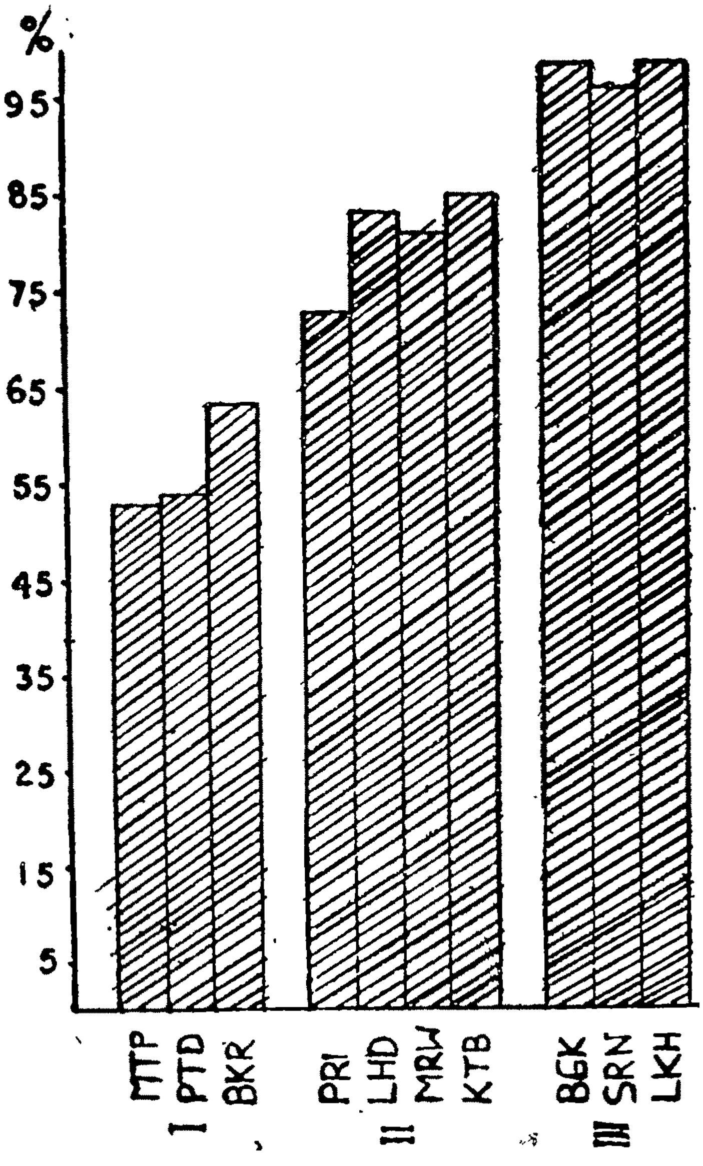
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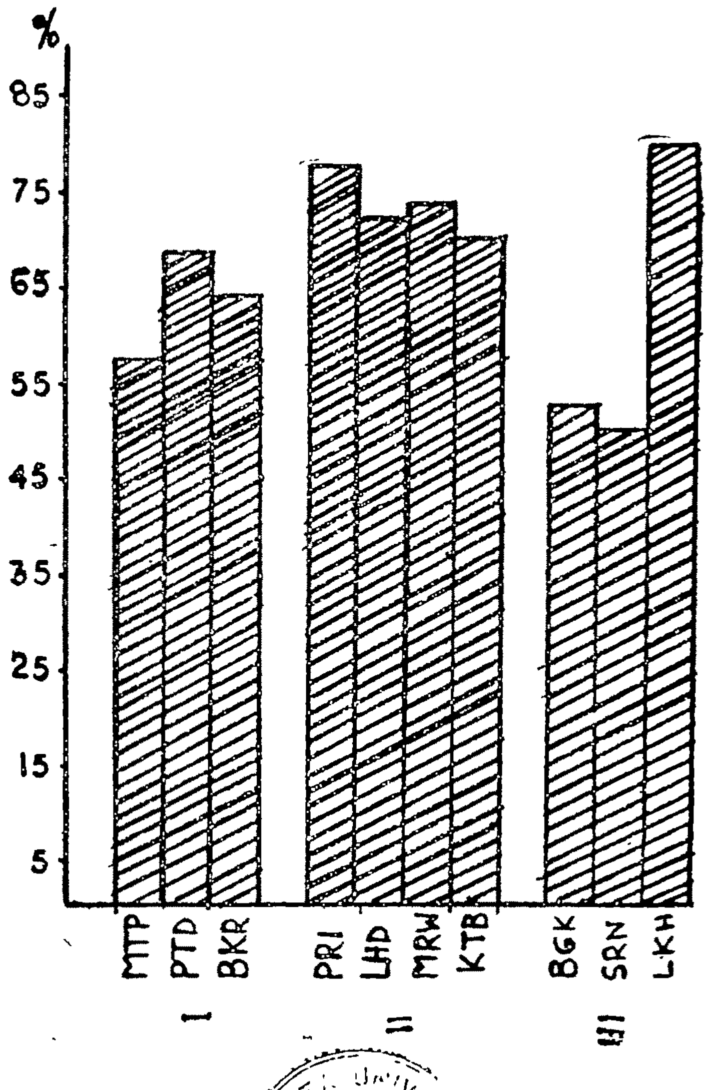
Fig. 2

Fig. 1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SRN
LKH
III

the early stage present prominent bulb of percussion, it appears that they were removed by direct percussion method. But in the later stage the blades become thinner with diffused bulb without bulbar scar which indicates indirect percussion method of blade removal from the fluted cores. In the third stage the fluted cores are all of microlithic proportion which suggests maximum exploitation of the raw material.

(4) Refinement in the core preparation technique is evident in the fact that in stage I the artifacts with irregular scar pattern present higher percentage but the percentage of artifacts with parallel or convergent scar patterns increase in stage II and III (Table 6) (Fig. 3).

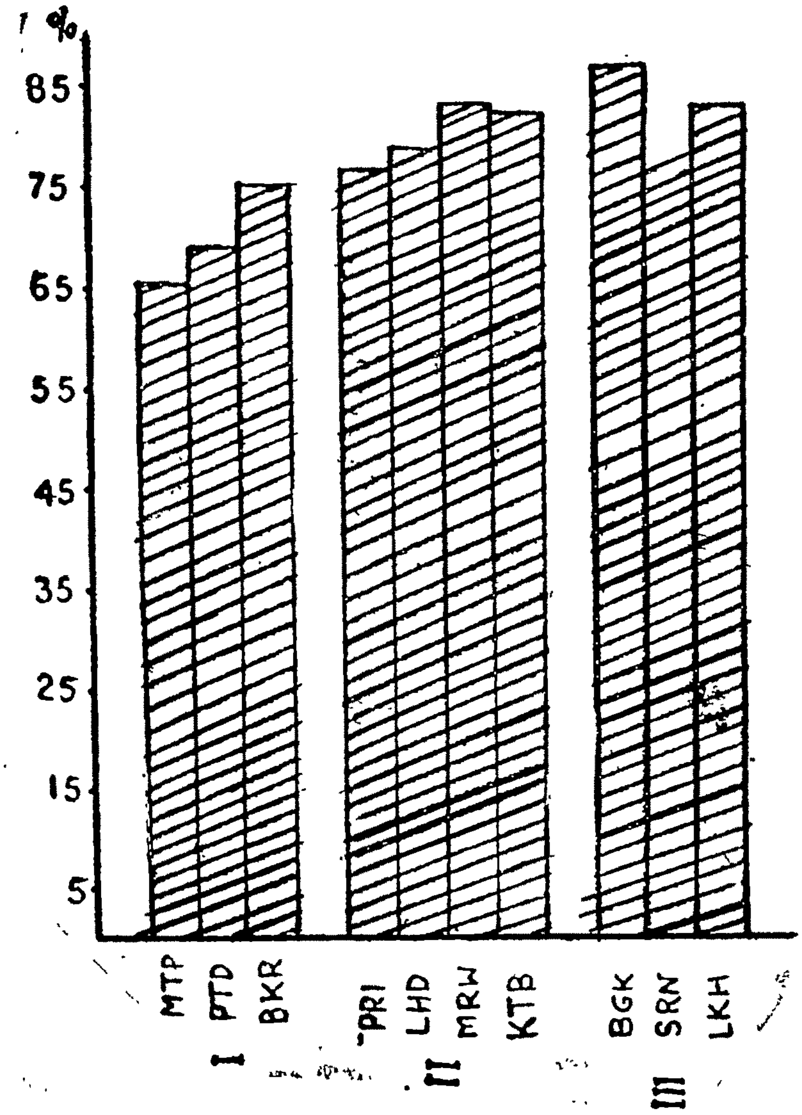

Fig. 3

TABLE 6

STATEMENT OF THE DORSAL SCAR PATTERN

		Parallel or Convergent	*Irregular*
ST-I	MTP	65.4	31.3
	PTD	68.9	33.3
	BKR	75.2	20.3
ST-II	PRI	76.4	16.1
	LHD	78.7	15.2
	MRW	82.8	15
	KTB	82.0	13.9
St-III	BGK	86.3	9.2
	SRN	71.0	15.5
	LKH	82.6	12.8

TABLE 7

COMPARATIVE DATA OF BACKED & RETOUCHED BLADE

		Backed Blades (%)	*Retouched Blades* (%)
I	MTP	1.65	6.6
	PTB	6.9	8.8
	BKR	12.5	7.1
II	PRI	28.0	9.3
	LHD	38.9	9.6
	MRW	36.2	10.9
	KTB	25.6	15.0
III	BGK	74.0	17.6
	SRN	80.2	4.1
	LKH	74	15.0

(5) As regards the blade tools (i.e. backed blades, retouched blades, composite blades, blades etc.), Stage—I presents very low percentage e.g.

MTP—14.9% (of the total finished product)
PTD—20.8% (of the total finished product)
BKR—24.2% (of the total finished product)

In the stage II it presents nearly half of the finished products—e.g. PRI—45.8%
LHD—56.1%
MRW—56.3%
KTB—52.7%

and in the stage III it dominates the total finished products e.g. BGK—96.6%
SRN—89.1%
LKH—96.5%

(6) A marked developmental sequence can be observed in the comparative data of backed blades and retouched blades (Table—7). Not only new types of backed blade tools make their appearance, in each stage its number also go on increasing (Fig. 4).

So far the retouched blades are concerned it is the only blade tool which has been found in all the three stages in good number and with the development of blade technology, its percentage also increases (Fig. 5). One most striking feature of these retouched blades has been observed that for preparing the working edges of these blades mostly scaliform retouching has been done, but so far as the retouched class is concerned mostly normal retouching has been done ; but as is evident in the following table No. 8 (Fig. 6) with the development

TABLE 8

COMPARATIVE STATEMENT OF THE RETOUCHED CLASS

		Normal Retouching	*Inverse Retouching*
St-I	MTP	55.5	14.5
	PTD	61.4	17.4
	BKR	58.7	18.5
St-II	PRI	61.0	24.7
	LHD	65.7	29.4
	MRW	63.2	25.3
	KTB	59.1	29.1
St-III	BGK	36.0	52.4
	SRN	53.4	38.0
	LKH	47.1	44.5

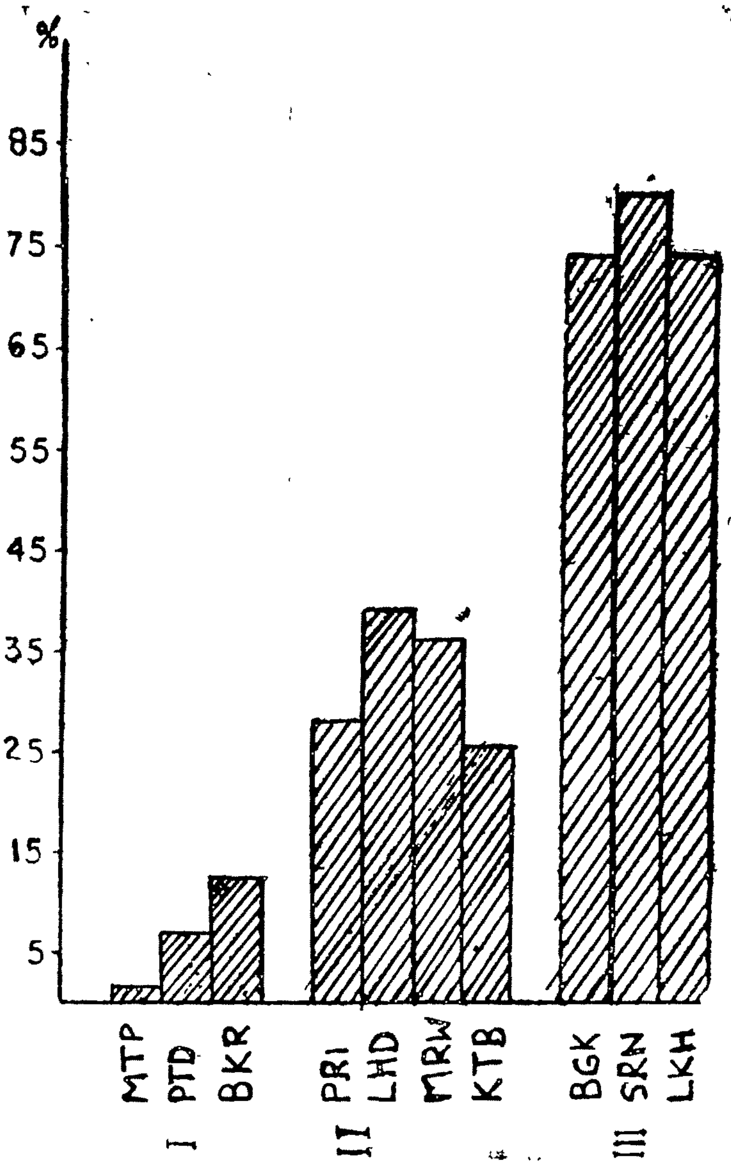
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Fig4.

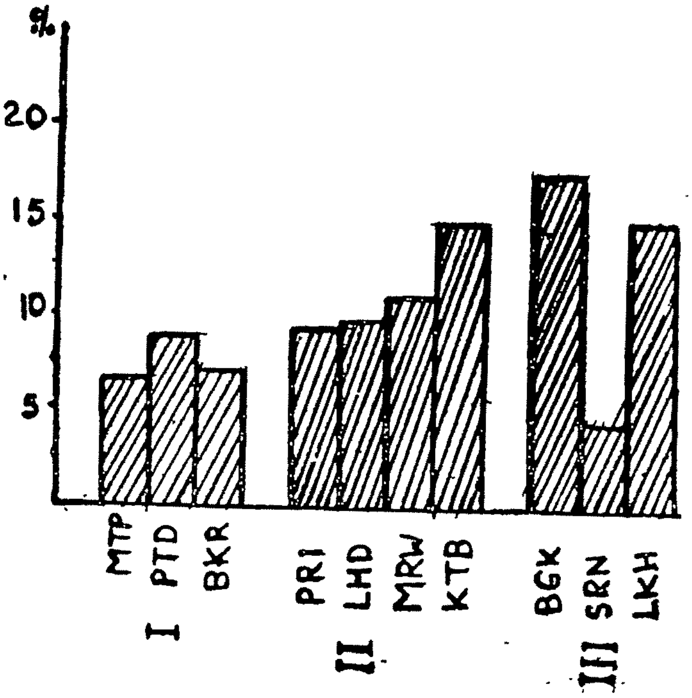
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Fig. 5

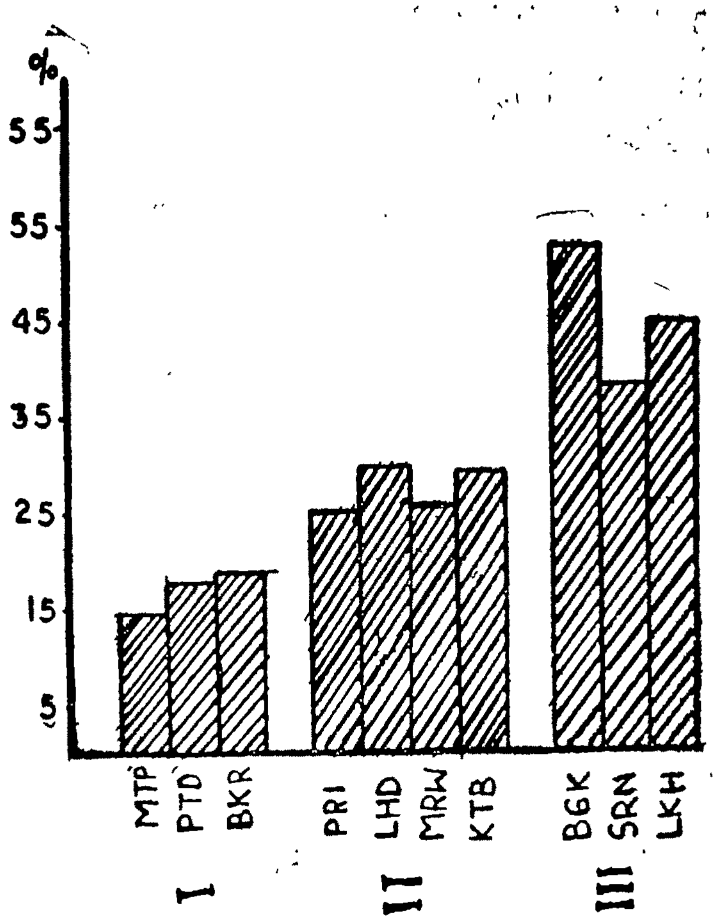

Fig 6

of blade technology high incidence of inverse retouching is more typical in the latter stage.

(7) So far as the other artifacts of these three stages are concerned most important developmental sequence which comes into light is that in the early stage most of the artifacts (e.g. scrapers, end scrapers, burins, notched tools, denticulates etc.) have been prepared on flakes, but in the later stage these have been prepared on blades.

So far as the raw materials are concerned chert was the most common raw material for fabricating the implements. But with the development of blade technology, a tendency of using the semi-precious stones like—chalcedony, agate, carnelian, jasper etc. over chert is evident.

From the above discussion there can be no two opinion that the area of south Uttar Pradesh presents a more systematic and continuous developmental sequence of blade tool industry right from the Upper Palaeolithic period through the transitional period to the Mesolithic period.

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Fossil Woods from Khaigam, Lower Karewa, Kashmir

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INTRODUCTION

The Karewas are the terraced flat topped mounds exposed in the valley of Kashmir along the northern slopes of the Pirpanjal mountain extending from north-east to southwest across the Jammu and Kashmir State. These mounds have revealed the remains of pleistocene vegetation in the form of leaf and fruit impressions, carbonised woods and subfossil pollen and spores. Though a good deal of attention has been paid towards the identification of pollen (Singh 1963 ; Vishnu Mittre 1966) ; Sharma et al. 1985 ; Gupta et al. 1985 and others) and leaf and fruit impression (De Terra and Paterson 1939 ; Puri 1945, 1948, 1957 ; Awasthi and Guleria 1982) yet very little has been done in regard to the carbonised woods (Lone et al ; 1985). The present communication reports the carbonized woods recovered from Khaigam in the lower karewas.

MATERIALS AND METHODS

The lithology of the locality from where the carbonized woods have been collected is given in Fig. 1. The woods were first bleached in 20% NaOH solution for 48 hours to remove the extraneous materials and then softened by boiling in water for about 8 hours and treatment with 10% Acetic acid solution for 3-6 hours. The interval of treatment varied in different woods till the softening was achieved (which was tested by inserting nail into the wood). The woods were thoroughly washed

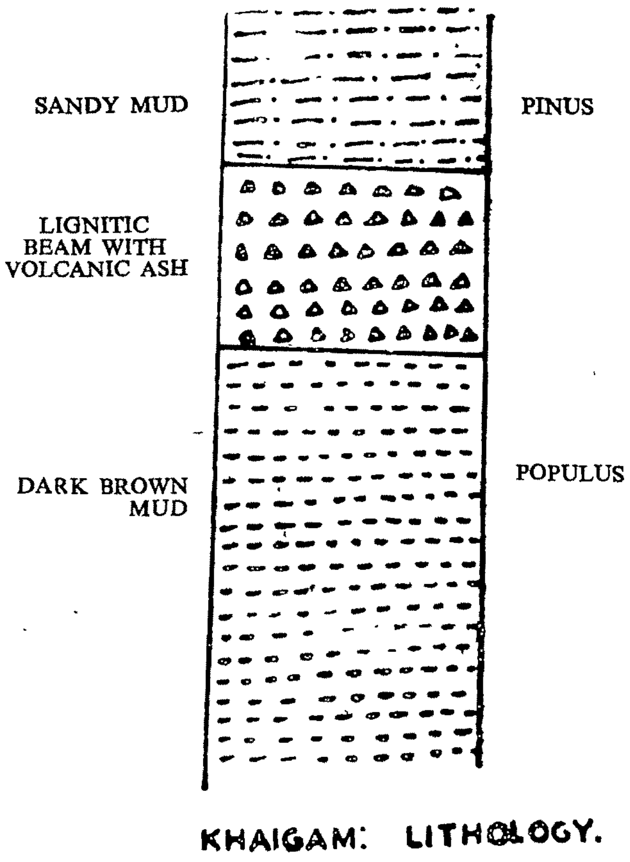

Fig. 1. Sithology of Khaigam

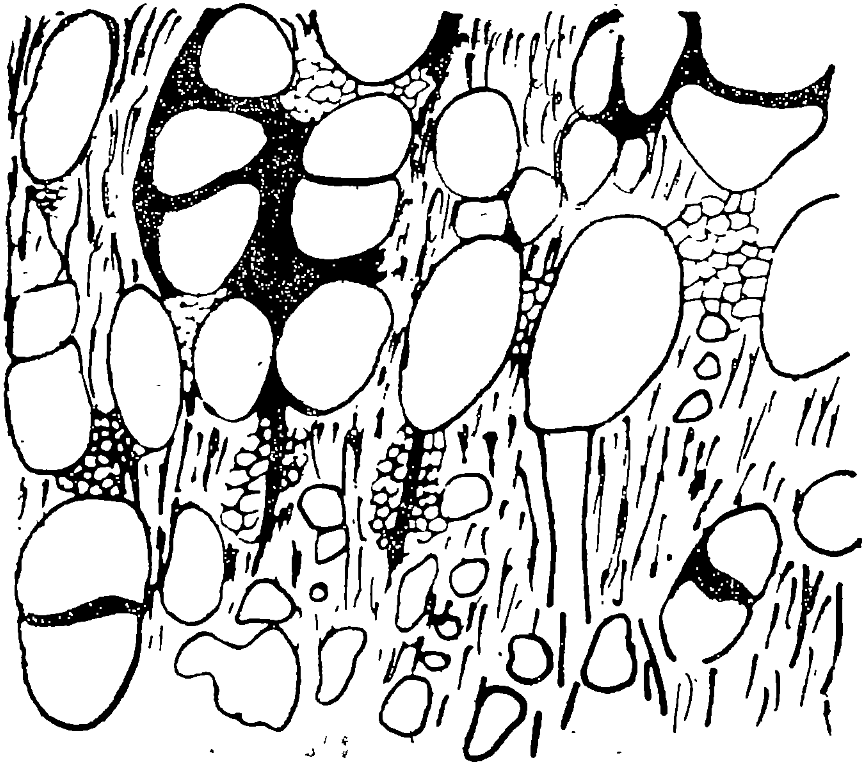

Fig. 2. T.S. Wood I (Populus)×100

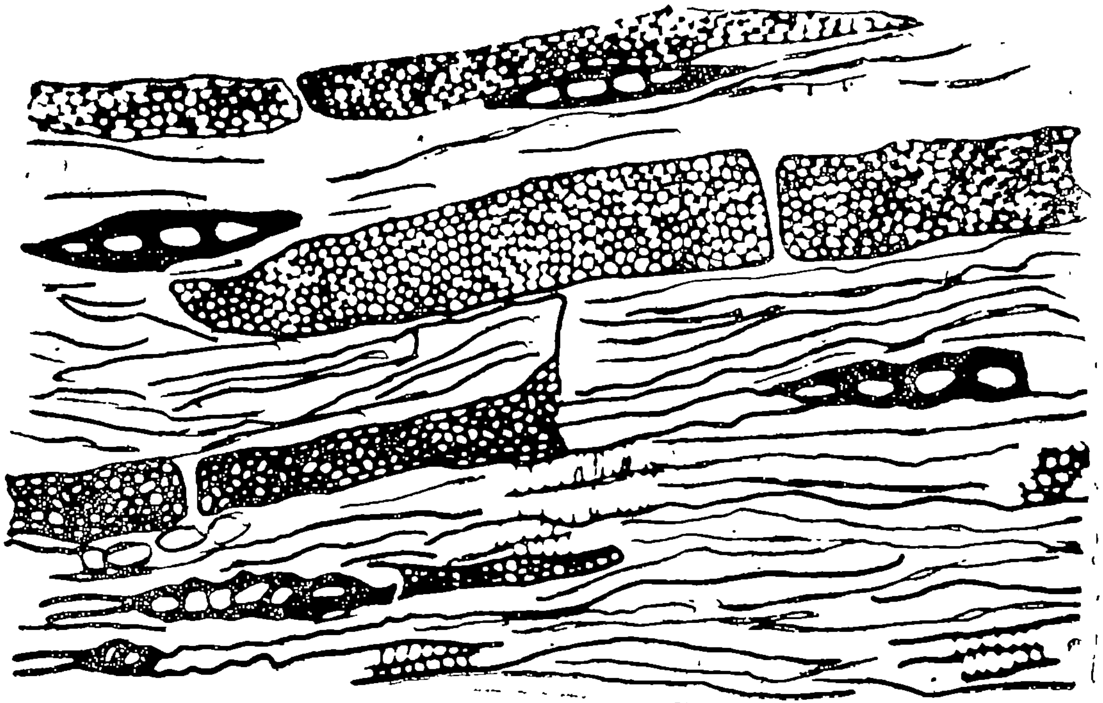

Fig. 3. T.L.S. of Wood I×100

in tap water and sections were cut over a wood microtome at 10-15 um along transverse, tangential longitudinal and radial longitudinal plains. After dehydration the sections were mounted in Hoyer's medium. Identifications were made by comparison with the living counterparts.

AGE OF THE SAMPLE

Using magnetic—polarity stratigraphy (MPS) and fission track dating of the intercalated volcanic ash from the same locality, Burbank (1985) has estimated the age as 2.4± 0.3 million years.

RESULTS

Wood I (Fig. 2, 3).

The wood is diffuse porous. Growth rings are not prominent. Vessels numerous, small to medium sized, solitary or in groups of upto 4, round to oval in shape, 30-145 per sq. mm. having a diameter of 75 to 200 um. Intervessel pitting orbicular to oval, large upto 15 um in diameter. Parenchyma appears to be terminal. Fibres thin to medium thick walled upto 40 um in diameter, angular in cross section. Rays unstoried, uni-seriate upto 8 cells in height, essentially homogenous.

These characters lead to two genera of Salicaceae viz. *Salix* and *Populus*. *Salix* can be eliminated as its rays are always heterogenous (Jane, 1955). Thus the wood is identified as belonging to *Populus* sp.

Wood II (Fig. 4, 5)

The wood is highly compressed and devoid of vessels i.e. it is a non-porous wood. Growth rings are distinct. Bulk of the wood is made up of tracheids

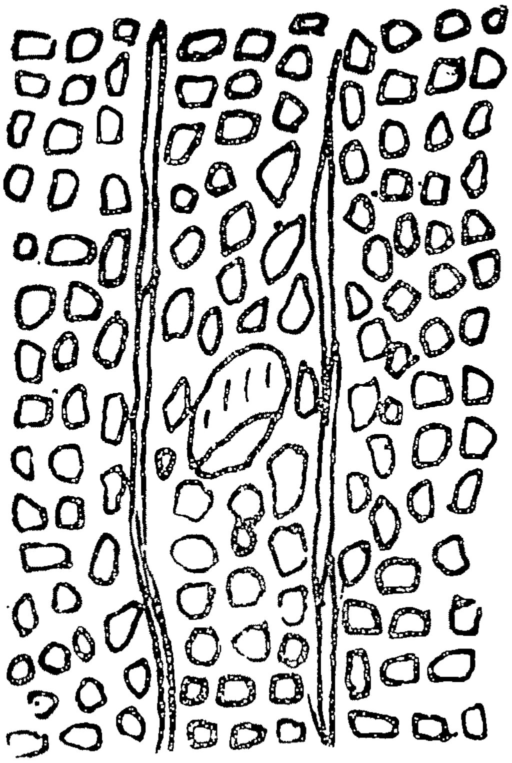

Fig. 4. T.L.S. Wood II (Pinus) × 100

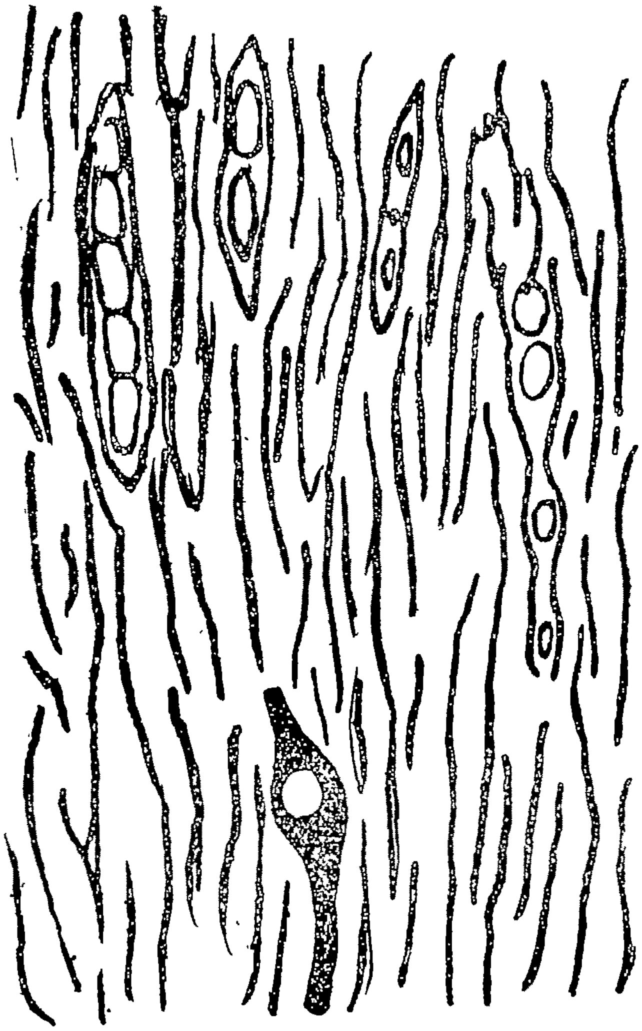

Fig. 5. T.L.S. Wood II × 400

aligned in definite radial rows. Tracheids are rectangular to squarish in shape. Vertical resin canals are present. Rays are uniseriate, 3-8 cells in height.

These characters bring the unknown close to *Pinus* and *Picea* among the conifers. On comparison, the unknown showed closest resemblance with *Pinus* sp.

DISCUSSION

Godwin Austen (1964) was the first to report plant fossils in the form of leaf impressions from karewa beds exposed near Hirpur. Middlemiss (1911), De Terra and Paterson (1939), Puri (1945, 1948, 1957), Awasthi and Guleria (1982) made substantial contributions to the mega-fossil flora of the Karewas. Most of the megafossils reported by these workers were in the form of leaf and fruit impressions. Though carbonised woods are frequently encountered in the Karewa beds, yet very little attention has been paid towards them. This is partly due to the petrified nature of these wood remains which renders their identification very difficult.

The wood remains dealt with here were collected from the karewa section exposed at Khaigam. These were retrieved around the volcanic ash whose age has been determined as 2.4 million years (Burbank, 1985). There are no other records of the paleovegetition from the locality either in the form of megafossils or pollen. A clear picture of the vegetation will become available only when a comprehensive pollen analysis of the locality is accomplished. The presence of *Populus* and *Pinus* reveals the prevalence of a mixed type of forest in which both the conifers and the broadleaved plants were important constituents and also indicates the prevalance of a somewhat cool temperate climate.

ACKNOWLEDGEMENT

We express sincere thanks to Mr. Navin Juyal for help in sample collection and also Prof. D.P. Agrawal of PRL Ahmedabad and Head, Department of Botany, University of Kashmir for providing facilities in the field and laboratory respectively.

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Middle Palaeolithic Sites in the Paleru Valley, Prakasam District, Andhra Pradesh

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The author's investigations in the Paleru valley in Prakasam District in Andhra Pradesh over an area of 2500 sq. km have brought to light 13 lower, 7 middle and 3 upper palaeolithic sites. The Paleru valley lies between 15°-15′ and 15°-30′ N latitude and 79°-15′ and 80°-5′ E longitude. The river originates at Velikonda hills at an altitude of 180 metres above the sea level and after draining through Kanigiri and Kandukur taluk flows directly into the Bay of Bengal with an easterly journey of 112 km.

A noteworthy feature of the area is the diversity of its geological and geomorphic record. In the piedmont region one comes across an extensive erosional plane. The intermediary zone preserves excellent evidences of pleistocene fluvial activity as also human occupational evidences in their primary contexts. The littoral zone on the other hand shows truncated topography indicative of neotectonics. The forests in the valley support only thorn scrub type of vegetation and the mean annual rainfall is only 740 mm.

The middle palaeolithic evidence from the 7 sites is presented in this paper. These are (1) Katretipuram (KTP), (2) Yeruvaripalle (YVP), (3) Agraharam (AGH), (4) Gollapalem (GLP), (5) Oguru (OGR), (6) Singarayakonda (SRK) and (7) Nandanamarella (NMR). All are open-air sites. The tools are made on both coarse and fine grained quartzite, and to a lesser extent on quartz. The entire collection is fresh except for a few specimens showing signs of slight rolling. Most of the tools are made on flakes removed from water worn pebbles. The flake scars in majority of the cases are clear with razor sharp margins. A few specimens however, show a brownish or cream coloured patina as well as patches of concretion.

The collection in the first instance is classified into two categories, viz., (1) shaped tools and (2) simple artifacts. The type-and-site-wise classification of artifacts are given in the table.

SHAPPED TOOLS

Scrapers (254 Specimens : 80. 13%)

These constitute the largest shapped tool category in the collection. These have been divided into the following types : Side-scrapers (106); End-scrapers (46); Double-scrapers (42): Combined-scrapers (22); Discoidal-scrapers (12); Perimetal-scrapers (15) and nosed-scrapers (11).

(a) *Side-scrapers* (106 specimens)

Only two specimens are made on quartz and the remaining on quartzite. Of these 99 are fashioned on flakes, on blades and 7 on small nodules. Trimmed edge forms are varied; convex (62), concave (28), straight (14) and irregular (2). The nature of edge trimming is shallow in 89 specimens and steep in the remaining 17 specimens. Six specimens are bifacially trimmed and the rest are unifacial. Three specimens are slightly weathered and patinated. Eight specimens are rolled and the rest are extremely fresh.

Type-And-Site-Wise Distribution Of Middle Palaeolithic Artifacts

Tool-type	*KTP*	*YVP*	*AGH*	*GLP*	*OGR*	*SRK*	*NMR*	*Total*	*% of shaped tools*	*% of total artifacts*
A. *Shaped tools*										
1. Scrapers	52	26	48	14	18	22	74	254	80.13	45.28
2. Borers	2	1	4	1	2	1	1	12	3.78	2.14
3. Points	3	2	6	—	—	3	2	16	5.05	2.85
4. Combined tools	—	1	1	—	—	—	—	2	0.63	0.63
5. Choppers	1	—	3	—	—	—	3	7	2.21	1.25
6. Discoids	1	—	3	—	—	—	1	5	1.58	0.89
7. Handaxes	6	—	11	—	—	—	4	21	6.62	3.74
B. Simple Artifacts										
8. Utilized flakes	8	6	12	6	8	6	10	56	—	9.98
9. Simple flakes	12	8	22	14	6	8	12	82	—	14.62
10. Cores	2	—	4	1	—	2	3	12	—	2.14
11. Blade-flakes	6	—	4	2	1	3	5	21	—	3.74
12. Chips	21	5	28	4	3	3	9	73	—	13.01
	114	49	146	42	38	48	124	561	100.00	100.00

Frequencies of Main Classes of Finished Tools in the Adjacent Districts of Andhra Pradesh Middle Palaeolithic

Tool type	*Prakasam Paleru*		*Nellore*		*Chittoor*		*Sagileru*		*Cuddapah Gujan Valley*		*Kurnool*	
	No.	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
Scrapers	254	80.13	397	66.95	154	77.00	144	60.50	12	11.01	191	35.30
Points	16	5.05	106	17.87	20	10.00	47	19.75	—	—	257	47.50
Borers	12	3.78	30	5.06	3	1.50	17	7.14	1	0.91	19	3.51
Combined tools	2	0.63	—	—	—	—	—	—	—	—	55	10.17
Handaxes	21	6.62	60	10.12	23	11.50	9	3.78	73	66.97	—	—
Choppers	7	2.21	—	—	—	—	10	4.20	—	—	19	3.51
Discoids	5	1.58	—	—	—	—	11	4.62	23	21.10	—	—
Total	317	100.00	593	99.98	200	100.00	238	99.99	109	99.99	541	99.99

The length/breadth/thickness measurements range from 86×58×27 mm to 32×19×7 mm with an average of 49×38×15 mm.

(b) *Ends-scrapers* (46 specimens)

The whole series is made on quartzite. Forty one are made on flakes, 4 on blade-flakes and one on a nodule. The working edge is formed at the distal end in all the specimens. The following edge forms are recognised in this group : convex (29), concave (12), straight (4) and oblique (1). Only two specimens have bifacial trimming while the remaining are unifacially trimmed. The edge trimming is shallow in all the specimens except in two which are steeply trimmed. Only one specimen is rolled and the rest are extremely fresh. The length/breadth/thickness measurements range from 60×47×19 mm to 31×31×10 mm with an average of 48×38×15 mm.

(c) *Double-scrapers* (42 specimens)

One specimen is made on milky quartz and the rest on quartzite. Thirty nine are made on flakes and the remaining three on blade-flakes. This group of scrapers includes specimens with trimmed working edges on both the lateral margins. The working edges seen on both the lateral margines are as follows: convex-convex (16), convex-concave (12), convex-straight (6), concave-straight (2) and straight and straight (6). The edge trimming in all the specimens is shallow in nature. Only two are weathered and the remaining are fresh.

The length/breadth/thickness measurements range from 70×53×18 mm to 32×26×8 mm with an average of 49+38×13 mm.

(d) *Combined-scrapers* (22 specimens)

This group includes specimens with working edge combination on the lateral margin/s and at one of the distal ends. The whole series is made on quartzite. Eighteen specimens are made on flakes, 2 on blades and the rest on nodules. The combined working edges noticeable are : one lateral margin + end (20), two lateral margins + ends (2). All the specimens are unifacially trimmed and shallow in nature. Two are weathered and the rest are fresh.

The length/breadth/thickness measurements range from 75×51×18 mm to 36×26×11 mm with an average of 54×41×15 mm.

(e) *Discoidal-scrapers* (12 specimens)

All are made on quartzite. Ten are made on flakes and the rest are on nodules. Five are circular in outline and the remaining are nearly circular. The working edge extends nearly almost the entire circumference. Ten specimens are unifacially trimmed and the remaining are bi facially trimmed. The nature of edge trimming is shallow in 10 specimens and steep in the remaining two. All are fresh.

The length/breadth/thickness measurements range from 57×47×20 mm to 30×30×12 mm with an average of 42×39×14 mm.

(f) *Perimetal-scrapers* (15 specimens)

This term is used by M D Leakey (1971 : 6) to describe scrapers of various shapes (oblong, triangular or formless) in which there is a trimmed working edge on the entire circumference. Except for one specimen made on quartz, the whole series is made on quartzite. Twelve are made on flakes and the remaining three on blade-flakes. The present collection includes 5 specimens which are oblong, 6 triangular and 4 rectangular. The edge trimming in all the specimens is shallow. One specimen is rolled and the rest are fresh.

The length/breadth/thickness measurements range from 58×42×20 mm to 36×30×10 mm with an average of 46×37×14 mm.

(g) *Nosed-scrapers* (11 specimens)

The whole series is made on flakes of quartzite. This group of scrapers are characterized by a median projection of the working edge. The working edges are round in 8 specimens and nearly pointed in the remaining three. The edge trimming is shallow in all the specimens. One specimen is rolled and the rest are fresh.

The length/breadth/thickness measurements range from 50×39×14 mm to 30×22×9 mm with an average of 41×33×12 mm.

Points (16 specimens : 5.05%)

Two specimens are made on quartz and the remaining on quartzite. Except for one specimen made on a bladeflake the whole series is made on flakes. These specimens, considering their morphology, are classified as : simple points (12) and tanged points (4). Six specimens have single margin retouch and 10 examples have retouch on both the margins.

The length/breadth/thickness measurements range from 87×57×20 mm to 36×21×10 mm with an average of 46×39×13 mm.

Borers (12 specimens : 3.79%)

Except for one specimen made on quartz the whole series is made on flakes of quartzite. These are characterized by short pointed projections, generally at the distal ends and rarely on a lateral side. The present collection includes 11 specimens with a point at the distal end and one on the lateral side. These points are formed by means of bilateral trimming converging to a point in two examples. The borer points are blunt in two specimens while the remaining are sharp. One specimen shows patches of concretion on the dorsal surface. All are fresh.

The length/breadth/thickness measurements range from 64×47×23 mm to 31×26×9 mm with an average of 47×36×14 mm.

Combined Tools (2 specimens : 0.63%)

These two specimens according to Mrs. M D Leakey's (1971 : 214) classification would fall into scraper combination tools. Both are made on flakes of quartzite. The combination of tool-types noticed are : scraper and borer. Both are fresh.

The length/breadth/thickness measurements range from 66×49×16 mm to 60×43×15 mm with an average of 63×46×15 mm.

Choppers (7 specimens : 2.21%)

All are made on quartzite. Two of them are made on pebbles and the remaining on nodules These are classified as follows : Side-choppers (4), End-choppers (1) and Pointed-choppers (2). The working edge is flaked bifacially in two examples and the rest have unifacial working edges. The working edge in the side choppers extends for nearly the whole length of one of the lateral margins. All are fresh.

The length/breadth/thickness measurements range from 65×64×27 mm to 38×33×20 mm with an average of 50×42×24 mm. The length of the working edge varies from 137 to 63 mm with an average of 82 mm. The edge/circumference ratio varies from 68% to 42% with an average of 57%.

Discoids (5 specimens : 1.58%)

Two examples are made on quartz and the rest on quartzite. In over all plan form all are circular in shape. Three examples are bifacially worked and the remaining are unifacial. The edges are sharp in 4 examples and blunt probably due to utilization in the remaining specimen. One specimen is relatively flat on both the upper and the lower faces, another is markedly biconvex and the remaining are planoconvex with flat under surfaces. All are fresh.

The length/breadth/thickness measurements range from 58×55×29 mm to 45×43×15 mm with an average of 51×48×22 mm.

Handaxes (21 specimens : 6.62%)

Three are made on quartz and the rest on quartzite. Three are pebble butted and the rest are fully flaked. In plan-form these belong to ovates (10), assymmetric ovate (1), limandes (4), cordates (3) and lanceolates (3) These are miniature in size and exhibit neat workmenship. The tip is either pointed or rounded. The working edge extends all over the circumference in all the specimens except in 3 pebble butted examples, In four specimens the working edge shows prominent use marks with blunted lateral margins. Four specimens have undergone some spheroidal weathering and one specimen shows patches of concretion. All are fresh.

The length/breadth/thickness measurements range from 85×67×33 mm to 55×31×14 mm with an average of 68×50×23 mm.

B. Simple Artifacts

These include the following types : Utilized flakes (56), Flakes (82), Blade-flakes (21), Cores (12) and Chips (73).

Utilized flakes (56 specimens)

The whole series is made on quartzite. In the course of their use for cutting, scraping, and such other operations these specimens have scarring and bruising along the edges. Twenty two specimens are end-struck, 18 are side-struck and the rest are indeterminate flakes. The utilized edges noticed are side (24), end (8) side and end (14) and 10 are utilized all round. Of these edges, 18 are straight, 21 convex, 9 concave, 4 notched, 3 irregular and the remaining one convergent. Twelve are slightly rolled and 44 are fresh.

Flakes (82 specimens)

These are classified as follows: end-struck (28), side-struck (32) and indeterminately struck flakes (22).

End-struck flakes (28)

Two are made on quartz and the rest on quartzite. Majority of these retained cortex on the dorsal surface. In plan view these are divergent (12), convergent (10), parallel sided (4) and irregular (4).

Side-struck flakes (32)

The whole series is made on quartzite. In plan view 18 are divergent, 11 are convergent and the remaining three are parallel-sided.

Indeterminate flakes (22)

Four are made on quartz and the rest on quartzite. Six are divergent, 12 are convergent and 2 are irregular.

Blade-flakes (21 specimens)

Under this category are grouped end flakes with parallel sides whose length/breadth ratio is slightly less than 2 : 1. They have one or two medial ridges on the dorsal surface while the ventral surface forms the plain flake surface in general. Six specimens show signs of use marks. Two are slightly rolled and the remaining are fresh.

Cores (12 specimens)

One specimen is on quartz and the rest on quartzite. These are the remnants of primary (raw) rock material used for detaching flakes and blade-flakes in order to prepare tools. These, in the present collection, are classified according to their shape as flat-based (5) and formless (7). Each core, on an average shows 11 flake scars.

Chips (73 specimens)

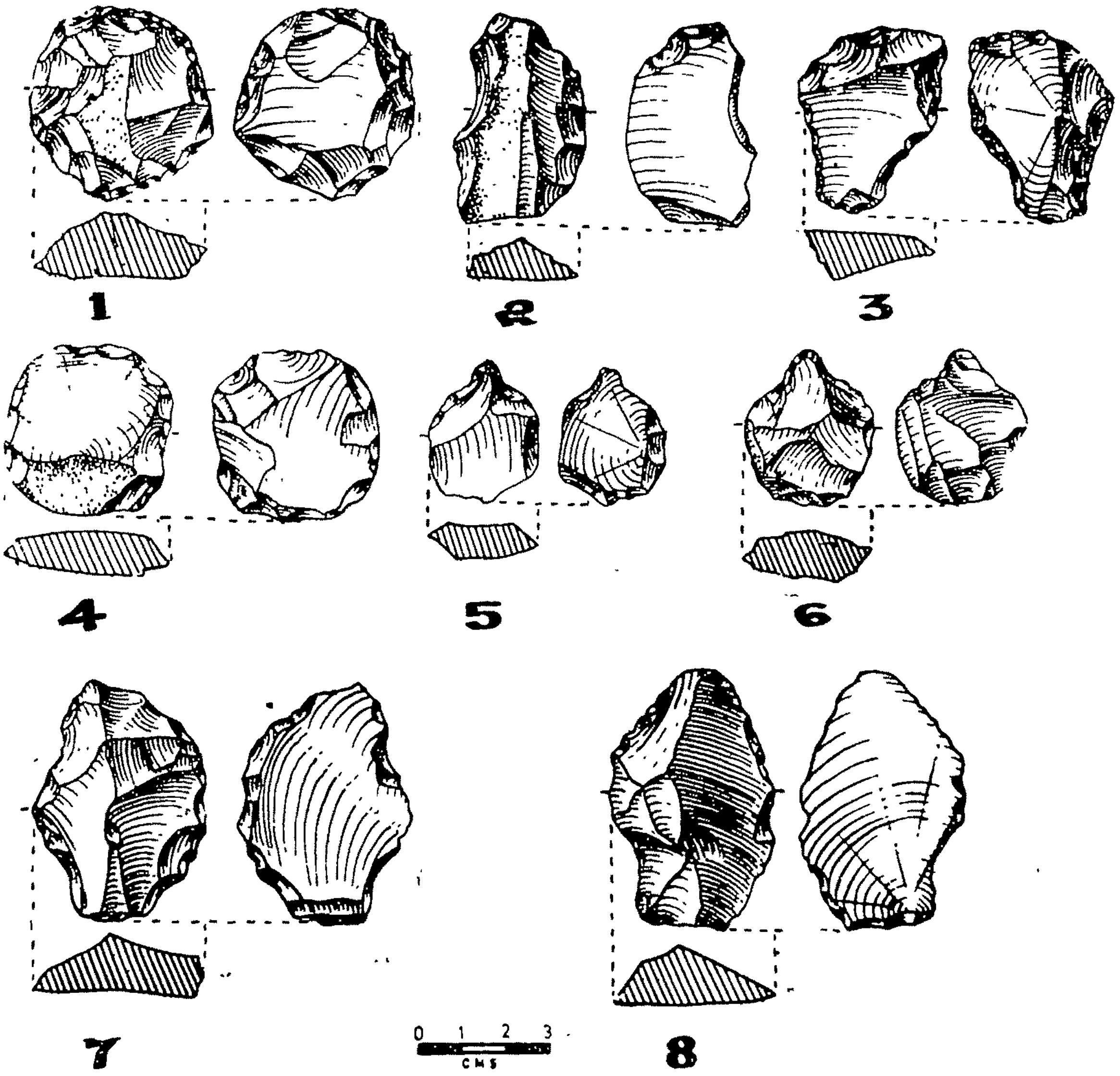
Eighteen are of quartz and the remaining of quartzite. These are small formless flakes and irregular pieces which resulted in the process of manufacture of tools. Eight are slightly rolled and the remaining are fresh.

CONCLUSION

The concentration of middle palaeolithic sites is specially in the middle and lower reaches of the valley. Interestingly some of the sites of this culture are quite away from the river Paleru (ex. Gollapalem, Oguru and Singarayakonda). At Singarayakonda this culture was obtained from the rain gullies and trenches associated with red lateritic gravel in the lower reaches of the valley.

The tools are made on flakes, levalloisian flakes and flake-blades. The sediments in which the middle palaeolithic tools were found was sandy and unconsolidated. Their mixed association with the lower palaeolithic cultures at some of the sites, continuation of the same raw material, some of the techniques and the tool types of the earlier culture suggests a gradual evolution from the late Acheulian phase to the Middle palaeolithic culture. It is likely that the late Acheulian and Middle palaeolithic co-existed for some time in the valley. At least it can be assumed that there may not be much time gap between these two cultures.

Scraper is the principal tool type of the industry. The other shaped tool types include points, borers, handaxes, discoids and choppers etc. The association of some of the tool types of earlier culture in miniature size may be taken as the persistence of culture which is not a peculiar feature to the valley alone and similar evidence from Middle palaeolithic industries has been reported from Chittoor (Murthy 66), Rajasthan (Misra 1967), Gujarat (Chakrabarti 1977) etc. By and large the industry displays a general agreement with similar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Middle Palaeolithic Tool-Types from Paleru Valley occurrences from the adjacent regions and with the middle palaeolithic industries of the Indian sub-continent in general, and from Karnataka and Maharashtra in particular. Prof. J D Clark who had seen the collection at Poona in December 1978 feels that the collection resembles the Middle stone age industries of Africa.

In the absence of any detable material for this culture we have to extrapolate the evidence from other nearer regions to date the culture. The middle palaeolithic cultures from Paleru Valley typo-technologically is similar to that of Maharashtra and must be more or less contemporaneous. The deposit yielding a huge carbonized trunk of "Terminalia arjuna" associated with this culture from Mulanagar in Maharashtra has been dated by C^{14} to 39,000 to 17,000 B.P. (Sankalia, 1974 : 146). In view of the similarity of middle palaeolithic cultures between these two regions the Middle palaeolithic culture from Paleru may also provisionally be assigned to the same date.

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An Upper Palaeolithic Phase in the Upper Mahanadi Valley, Madhya Pradesh

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GEOGRAPHIC SETTING

The Mahanadi valley forms the south-eastern part of M.P. and is known as Chhatisgarh region. The main geological formations of the area are the Archaeans, the Gondwanas, the Deccan traps, the Lametas, the Laterites and the Alluvium. The valley is an undulating country formed essentially with the fluvial processes. The plain is highly dissected by the streams of the valley. The sites in this valley are located in the vicinity of Cuddaph rocks dominated by Shale formations which were noticed along the river Seonath and over the Flood Plains in the form of the rock fragments of different sizes. It is worth mentioning here that the silica family minerals ie chert, jasper, agate, quartz and chalcedony rock pieces of various sizes were available at the sites. The plain is covered with the red, reddish-yellow and yellow soils nourishing dry deciduous types of vegetation, thorny thickets and scrub woodlands. The vegetation at present has gone sparse due to human interference with the nature. A typical monsoonal rainfall occurs in the valley between mid-June to mid-Sept. and has been classed as sub-humid. The area receives an average rainfall of about 1300 mm. per annum. May is the hottest month of the year and December, the coldest.

The Mahanadi is one of the easterly flowing rivers of India which rise from the hills of Sihawa in Raipur district of M.P. The river traverses varieties of land-forms in several district of M.P. and Orissa before debouching in the Bay of Bengal near Cuttack, Orissa. The total distance covered by the Mahanadi is about 1000 km and is fed by several left and right bank tributaries. An average gradient of the river is about 0.463 m/km. and has a total drainage area of about 1,32100 Sq. Km. The Seonath, the Hasdo and Jank are the major tributaries in the upper part of the Mahanadi.

THE SITES

Four Upper Palaeolithic sites have been found on the Seonath only (Fig 1), and are Simga (21°37′ N ; 81° 42′E), Bansankra (21° 36′ N ; 82° 36 E) in Raipur district and Amlidih (21° 48′ N ; 81° 55′ E) in Bilaspur district. At Simga four localities yielding Middle and Upper Palaeolithic sites have been distinguished among which locality III and IV are the Upper Palaeolithic sites. Of these, three are situated on the Seonath river very close to the channel while Bansankra is situated on the bank of Sitawar nala and is about 3 Km away from the Seonath. Recently six more Upper Palaeolithic sites have been discovered in the valleys of Seonath but only four sites as mentioned above are discussed here.

STRATIGRAPHICAL POSITION

A thick blanket of Quaternary deposits in the form of Older and Younger alluvium has been piled up which also preserve cultural remains. Two gravel deposits have been noticed : (a Pebble Conglometate and b) High Level gravels. The Pebble Conglomerate yielded Middle Palaeolithic industry and High Level gravels, Upper Palaeolithic.

The Upper Palaeolithic industry exhibits an interesting status in the valley. The sites come from two

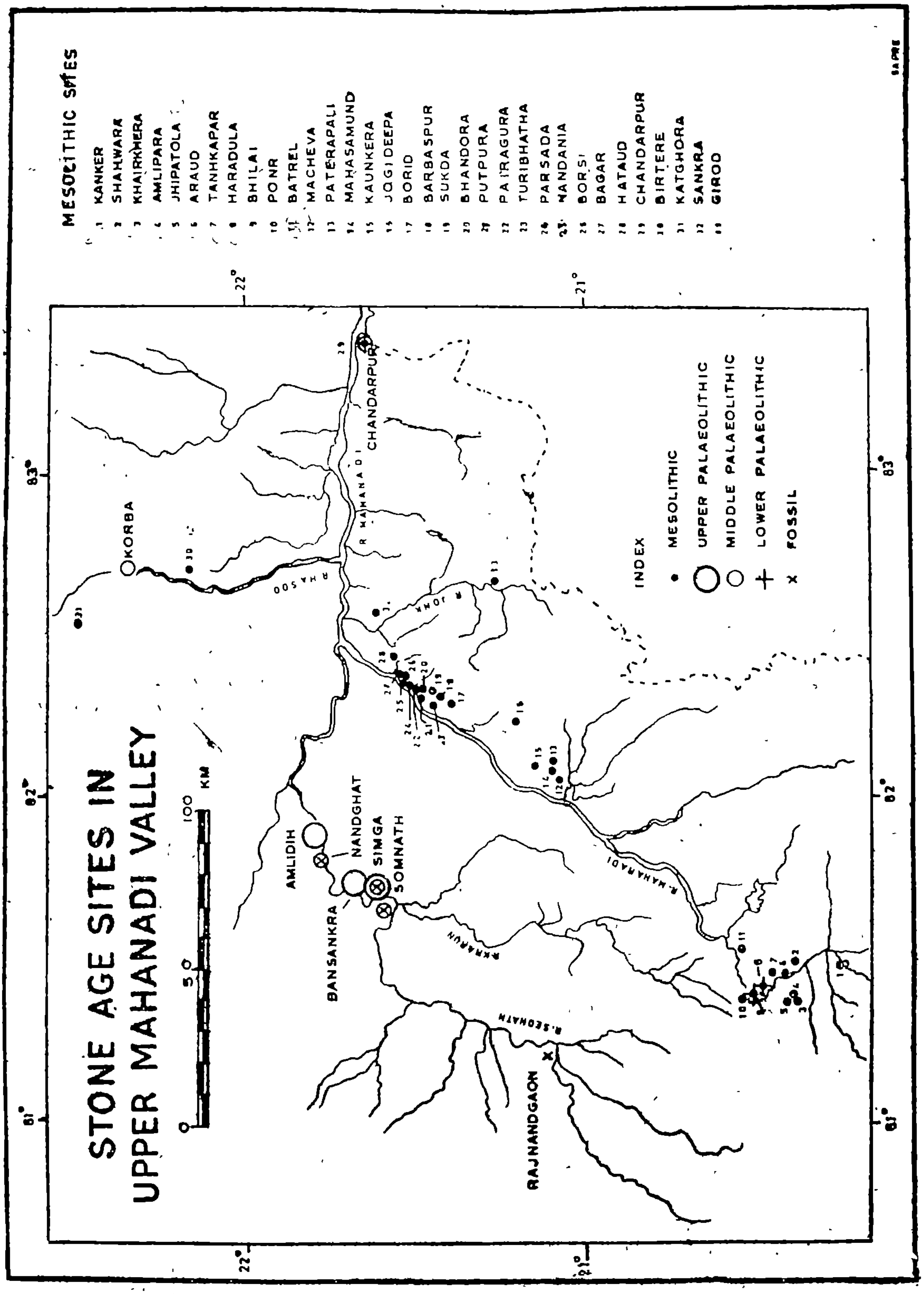
STONE AGE SITES IN UPPER MAHANADI VALLEY
0
50
100 KM
MESOLITHIC SITES
1 KANKER
2 SHAHWARA
3 KHAIRKHERA
4 AMLIPARA
5 JHIPATOLA
6 ARAUD
7 TANHKAPAR
8 HARADULA
9 BHILAI
10 PONR
11 BATREL
12 MACHEVA
13 PATERAPALI
14 MAHASAMUND
15 KAUNKERA
16 JOGIDEEPA
17 BORID
18 BARBASPUR
19 SUKDA
20 BHANDORA
21 PUTPURA
22 PAIRAGURA
23 TURIBHATHA
24 PARSADA
25 NANDANIA
26 BORSI
27 BAGAR
28 HATAUD
29 CHANDARPUR
30 BIRTERE
31 KATGHORA
32 SANKRA
33 GIROD
22°
21°
81°
82°
83°
KORBA
R HASDO
R MAHANADI
CHANDARPUR
R JONK
AMLIDIH
NANDGHAT
SIMGA
SOMNATH
BANSANKRA
R KHARUN
R SEONATH
R MAHANADI
RAJNANDGAON
INDEX
● MESOLITHIC
○ UPPER PALAEOLITHIC
○ MIDDLE PALAEOLITHIC
+ LOWER PALAEOLITHIC
x FOSSIL
SAPRE

FIG: 1

different environs ; High Level gravels and Flood Plains. The High Level gravels generally rest over Shale rock of Cuddapah formations, situated over the river banks very close to the main river. The gravels are 2-3 m. thick and pebbles are smaller than those of Pebble Conglomerate but the Flood Plain sites occur 3-6 Km. away from the present river bed and are found on slopy grounds littered with the fragments of Shale rock among which pieces of chert and other allied minerals were also observed. Such sites are generally situated along the bank of nalas covered with the red soils. Occasionally they are also located near the main river like Simga III. It is worthy of note that the tools found on the High Level gravels were fashioned out of the pebbles available in the gravels as indicated by the original pebble cortex on the tools while the tools at the Flood Plain sites were made from the rocks available at the site itself.

An interesting feature seen at these sites is that the High Level gravel sites are cruder in nature, tools are thicker and bigger showing closeness to the Middle Palaeolithic industries of the area, while the sites on the Flood Plain are rich, tools are comparitively smaller tending to microlithic, finer in workmanship seem near to Mesolithic industries of India, thus showing a gradual development of Upper Palaeolithic culture from Middle Palaeolithic to Mesolithic, in the Mahanadi valley.

THE LITHIC INDUSTRY

The total Upper Palaeolithic collection consists of 1512 specimens and come from Simga III (573), Simga IV (234), Bansankra (381) and Amlidih (198). They are employed on flakes, blades and work nodules but blade element in the present collection is significant. The burins also occur in this collection.

RAW MATERIAL

The tools at this site are manufactured on silica group of minerals ie chert, chalcedony, quartz and agate. The chert of different shades like red, green, black and white was exploited dominantly while chalcedony was preferred next in order. The raw material wise distribution is as under.

Raw material	*Number*	*Percentage*
Chert	839	55.49
Chalcedony	637	42.14
Quartz	30	1.98
Agate	6	0.39
Total	1512	100.00

A few tools in the collection are subjected to rolling and some have incrustaction marks over them.

TYPOLOGY

The total assembledge (1512) has been divided into two main categories ; Shaped tools (291 : 19.26%) and Simple artifacts (1221 : 80.75%). These main groups have further been classified in several subgroups and are given in Table-I. Although, the scrapers are dominant types but it is note worthy that varieties of scrapers are fashioned on the blades and flake-blades. The End scrapers are less on the High Level gravel sites (2 pieces) while on the Flood Plain sites they are more. Majority of them are fashioned on blades and flake-blades. Varities of points are also exhibited (29 : 9.96%). The burins which are one of the characteristics tools of this industry are as high as 10.32% (30 specimens) and are represented by Angled (9), Oblique (18) and Parrot beak (3) burins. Knives appear for the first time (Fig. 2 & 3). The blades and blade tools increase suddenly. Micro-blades have also been converted into tools after proper retouching. The Lunates, (Fig. 4) one of the important tool of the Mesolithic also make their appearance (13 ; 4.47%).

Since there is marked increase in the blade and micro-blade elements, statistical analysis has been carried out to differences between the blades and micro-blades of this industry. The mean values are as follows : (Fig 5).

Mean	*Length*	*Breadth*	*Thickness*
Complete blades	34.49	15.01	7.92
Complete micro blades	22.41	09.18	4.58

TABLE 1

SITE-WISE AND TYPE-WISE DISTRIBUTION OF THE UPPER PALAEOLITHIC TOOLS
SHAPED TOOLS (19.25%)

Tool types	*Simga III*	*Simga IV*	*Bansankra*	*Amlidih*	*Total*	*G. Total*	*%*
Side Scraper							
Concave	18	5	7	7	37		
Convex	23	3	6	4	35		
Straight	1	—	3	1	5		
Notched	5	4	4	1	14		
Double scraper							
Concave-convex	4	3	—	—	7		
Biconcave	2	—	—	=	2		
Straight-convex	1	—	—	—	1		
Combined scraper	1	4	—	1	2		
End scraper	9	2	3	—	14		
Core scraper	7	3	1	12	23	141	48.45
Borers	1	1	—	3	5	5	1.72
Knives	5	3	4	6	18	18	6.18
Burins							
Angular	3	—	2	4	9		
Oblique	7	1	6	4	18		
Parrot beak	1	2	—	—	3	30	10.32
Points							
Simple	1	2	4	4	11		
One margin retouched	5	1	3	3	12		
Both margin retouched	2	—	1	1	4		
Leaf shaped	—	—	1	1	2	29	9.96
Lunates							
Symetrical	1	—	—	—	1		
Asymetrical	1	1	3	—	5		
Broken	6	1	—	—	7	13	4.47

Tool types	Simga III	Simga IV	Bansankra	Amlidih	Total	G. Total	%
Blades							
One margin retouched	5	2	2	—	9		
Both margin retouched	—	1	—	—	1		
Backed blunted	4	—	3	—	7		
Oblique truncated	2	—	1	—	3	20	6.87
Micro-blades							
One margin retouched	6	1	—	1	8		
Both margin retouched	1	1	—	—	2		
Backed	3	3	5	1	12	22	7.56
Choppers	1	4	2	6	13	13	4.47
Total	126	44	61	60	291	291	100.00

SIMPLE ARTIFACTS (80.75%)

Total types	Simga III	Simga IV	Bansankra	Amlidih	Total	G. Total	%
Cores							
Flake cores	37	16	14	17	84		
Blade cores	7	7	7	4	25		
Micro-blade cores	20	16	20	9	65		
Discoids	—	1	—	—	1	175	14.33
Flakes							
End flakes	54	34	38	25	151		
Side flakes	18	14	18	6	56		
Indeterminate flakes	—	6	—	—	6		
Utilized flakes	24	—	—	—	24	237	19.41
Flake-blades	24	22	39	13	118	118	8.20
Core rejuvenation flakes	7	3	5	3	18	18	0.65
Blades							
Complete blades	26	14	42	18	100		
Broken blades	22	5	19	10	56		
Utilized blades	4	2	6	—	12		
Mid guided ridged blades	8	2	5	—	15	183	15.00
Micro-blades							
Complete Micro-blades	29	7	43	1	80		
Broken Micro-blades	47	6	13	—	66		
Utilised Micro-blades	4	—	4	—	8	154	12.62
Chips	125	31	45	19	220	220	18.00
Worked nodules	72	7	7	16	102	102	8.35
Rejects	42	—	—	—	42	42	3.44
Total	573	190	320	138	1221		100.00

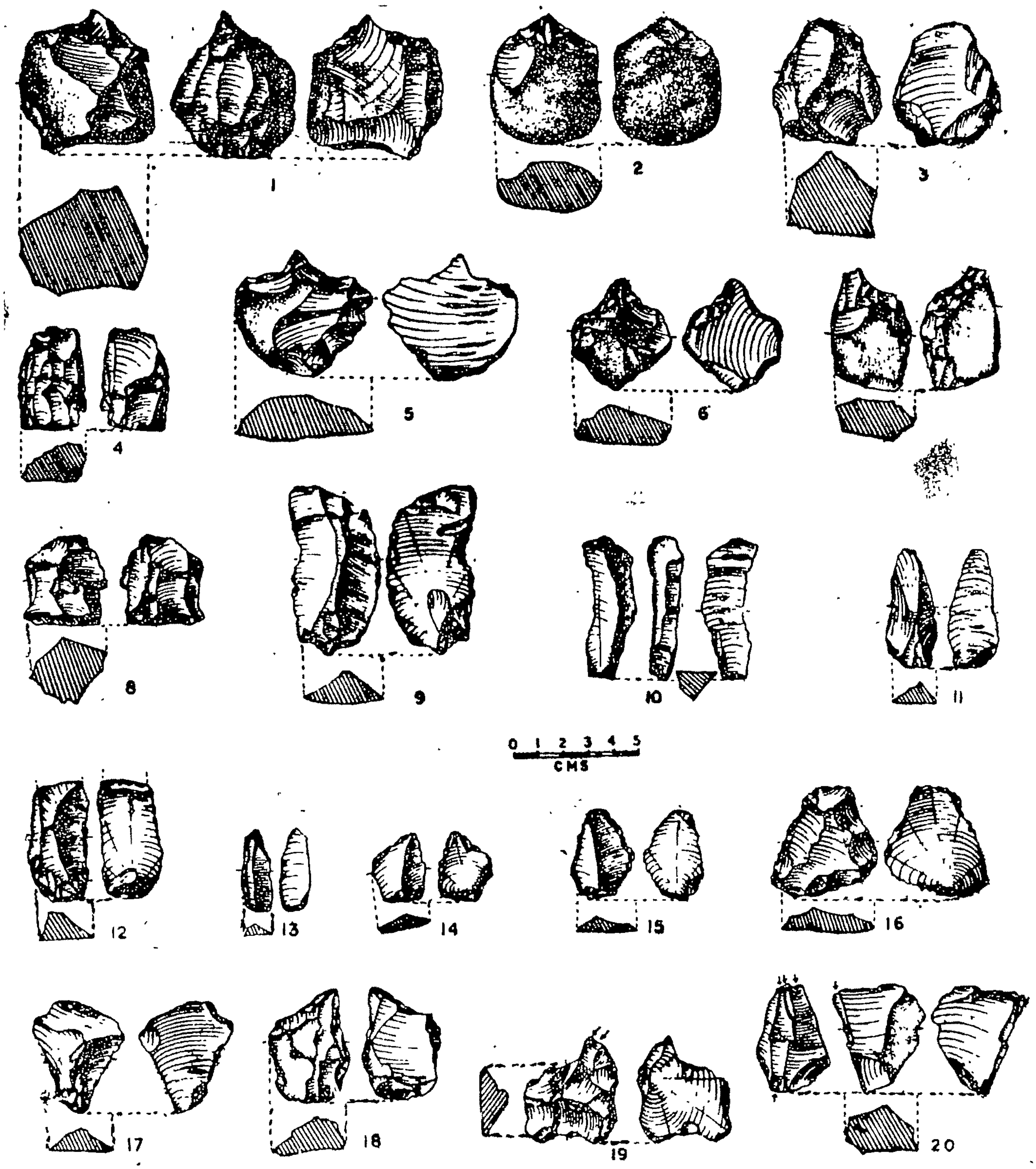
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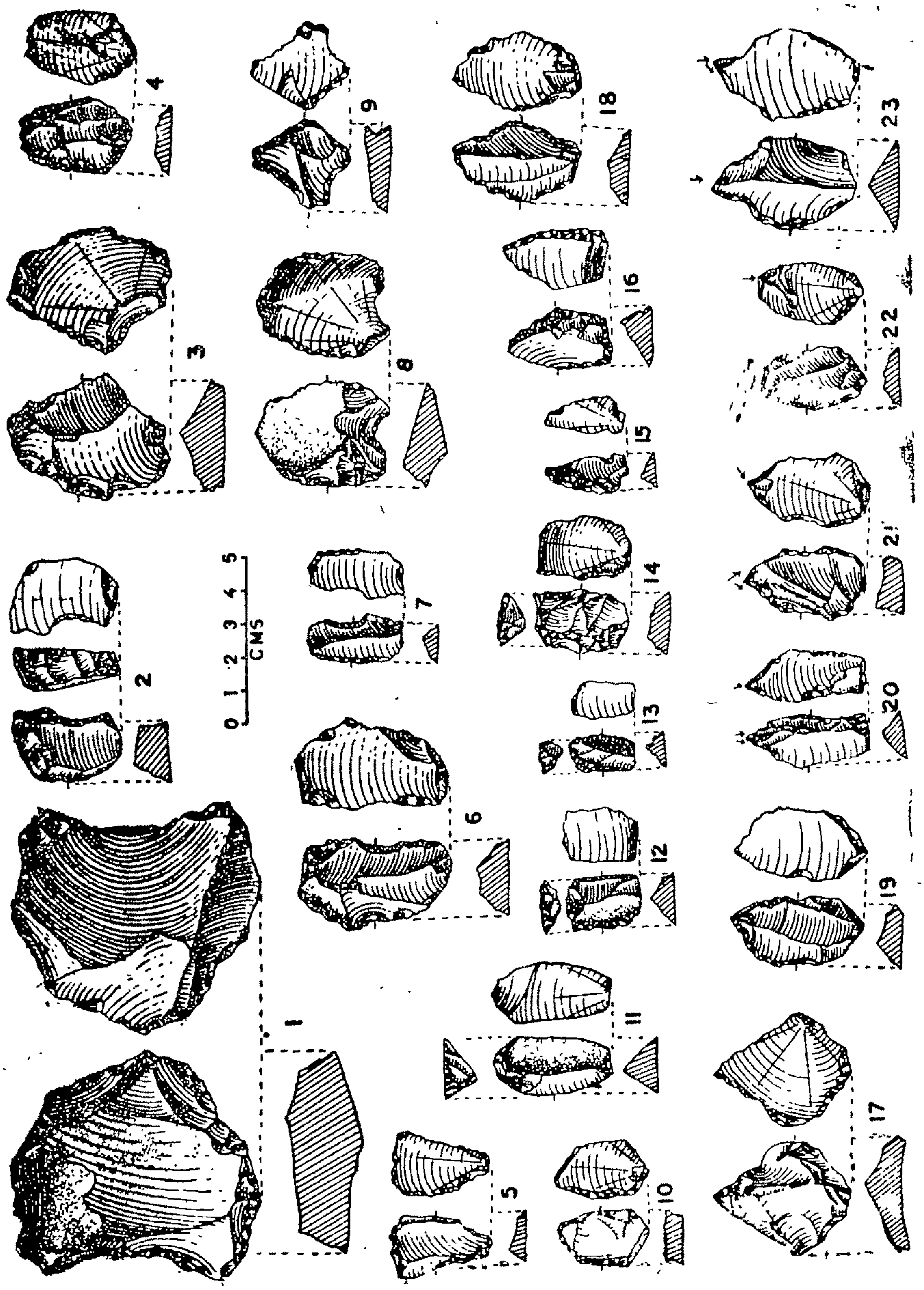
Fig. 2.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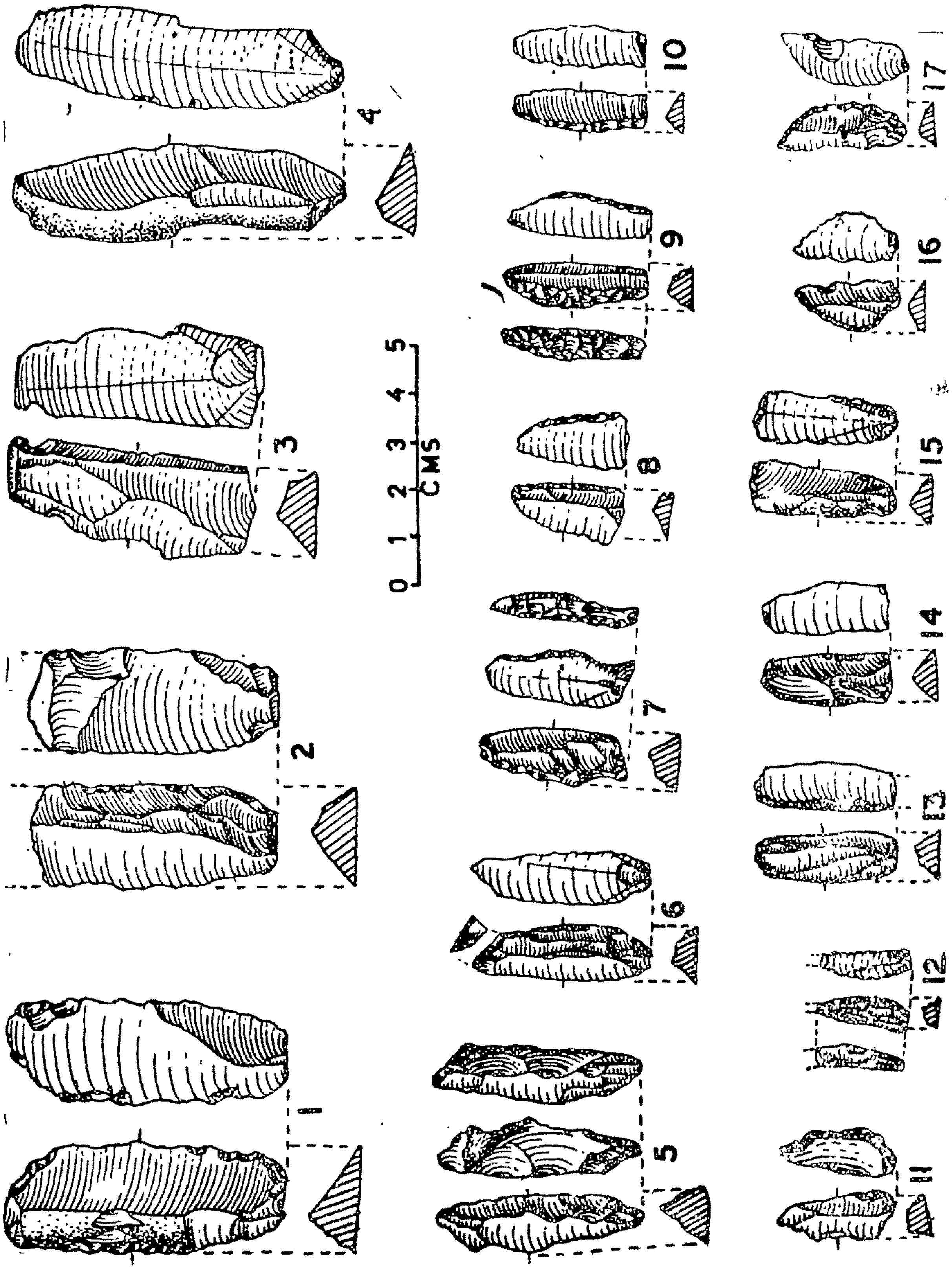
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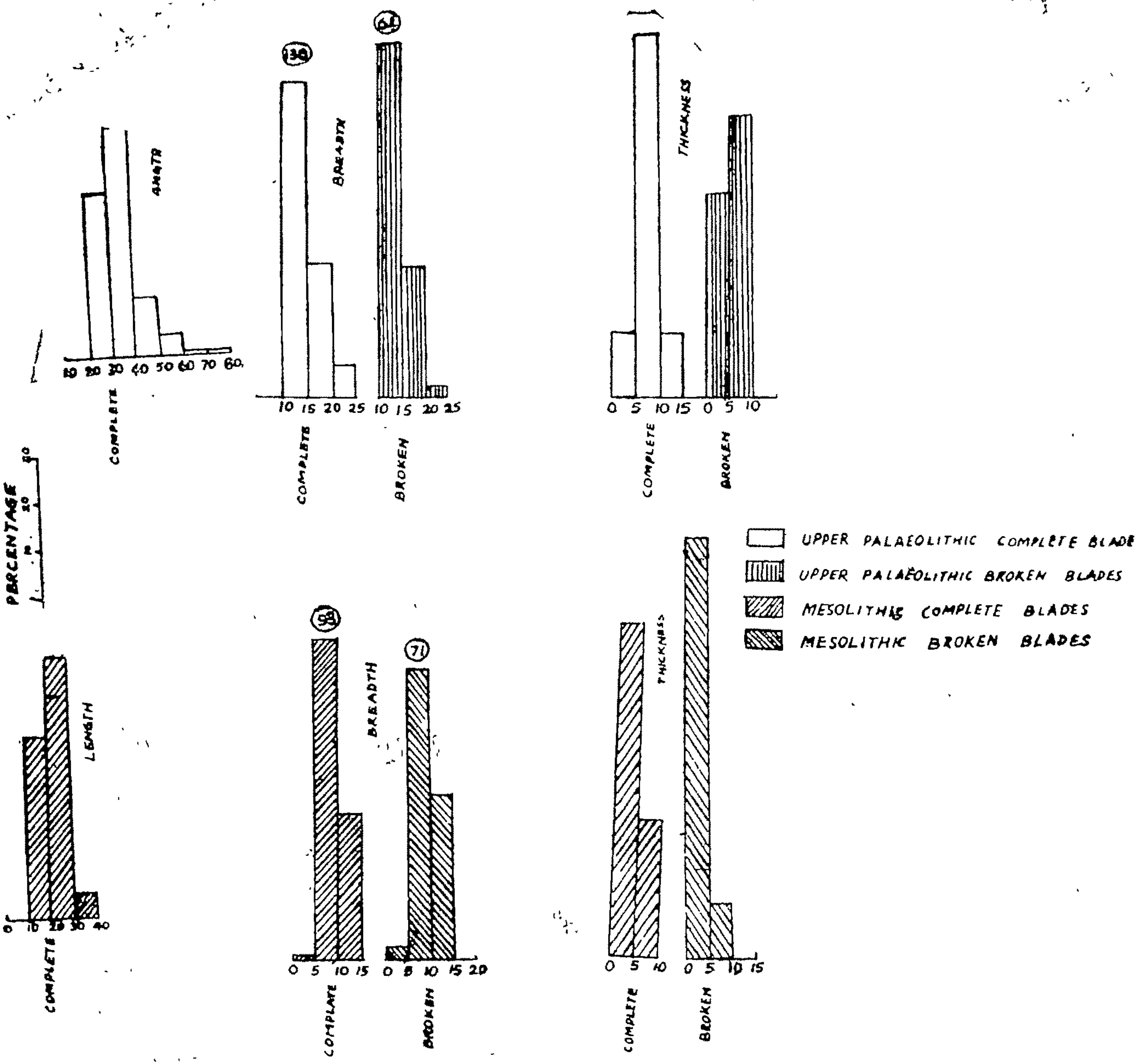

UPPER PALAEOLITHIC BLADES AND MICRO BLADES FREQUENCY DISTRIBUTION OF LENGTH BREADTH AND THICKNESS

Fig. 5.

It is interesting to note that there is clear cut difference in the mean values of blades and micro-blades.

Apart from Shaped tools, the industry comprised of Simple artifact debitage and are cores (14.33%), flakes (19.41%), flake-blades (8.20%), core rejuvenation flakes (0.65%), blades (15.00%), micro-blades (12.62%), chips (18.00%) and worked nodules (3.44%).

The Upper Palaeolithic industries of the area have been compared with other Upper Palaeolithic sites to bring out the salient features of these industries occurring more or less in the same environmental zones. The Wainganga (Joshi 1966) evidences show a close similarity with the Mahanadi. Both of these industries come from upper gravel employed on the cryptocrystalline group of minerals dominated by chert. Both the industries contain scrapers as a dominant tool type. But the tranchet of the Wainganga is completly absent in the upper Mahanadi while the micro-blades present in the upper Mahanadi are not found in the Wainganga valley.

Bhimbetka (Misrs *et al* 1977 and Misra 1982) exhibits a little difference from those of the upper Mahanadi. Bhimbekta is cave/rock shelter site having tools fashioned on the fine grained Quartzite. Against this background, it is interesting to the percentage of flakes and blades in the Mahanadi. The flakes in the Mahanadi is 22.97% against 26.80% at Bhimbetka. At the same time proportion of blades show a great difference between the two. The blades, in the Mahanadi are 13.47% while at Bhimbetka only 4.28%. It should however, be mentioned here that the Mahanadi collection is from surface or open staions and is not in that respect the total collection as at Bhimbetka.

As these industries are made on various types of materials the differences in their size is significant. The metrical analysis was carried out for comparision of various values of the blades of the upper Mahanadi as they form an important tool type in the Upper Palaeolithic industries and are as follows :

THE MAXIMUM, MINIMUM AND MEAN VALUES OF LENGTH BREADTH AND THICKNESS

	Length	Breadth	Thickness
Complete blades			
A-Bhimbetka (7)			
Maximum	85	34	19
Minimum	42	20	7
Mean	62	26	12
B-Mahanadi (138)			
Maximum	77	23	13
Minimum	24	12	4
Mean	34	15	8
Broken blades			
A-Bhimbetka (73)			
Mean	—	22	9
B-Mahanadi (64)	—	14	6
Broken Micro-blades			
A-Bhimbetka (22)			
Mean	—	19	7
B-Mahanadi			
	—	9	4

Thus the values of the blades and micro-blades at Bhimbetka are higher than those of the Upper Mahanadi. Perhaps the raw material has influenced the size of the tools.

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Neolithic Cord Impressed Ware of the Vindhyas

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The cord impressed ware, a typical ceramic industry widely distributed in early farming communities of south and south-east Asia, was for the first time reported in Indian Neolithic context from Assam in eastern India (Sharma : 1966). In central India from the Vindhyas it was found from Koldihwa in 1972 (IAR : 72-73). The location of the Neolithic Culture in the Vindhyas on archaeological map in the middle of present decade is one of the important achievements of Indian Archaeology. Though hundreds of Neolithic celts, adzes, pounders and hammer stones (Allchin : 19 8) were reported from surface sites, fields, below trees, worship platforms etc. in the Vindhyan plateau, but their stratigraphic context and archaeological horizon was unknown. A recent morphological study of the Neolithic celts show that from the Bundelkhand region of the Vindhyas only triangular variety of the stone axes with curved medial ground edges corresponding to the principal type of southern Neolithic were collected, while in the Baghelkhand most frequent type was the rounded variety of the celt with rectangular or ovaloid cross-section, fully ground and polished, very popular in the Eastern Neolithic Culture (Pal 1983). Of the two morphological types of the Neolithic celts—triangular and rounded, reported as surface finds, rounded celts for the first time were found in definite stratigraphic archaeological context in 1972 (IAR : 72-73) in the excavation at Koldihwa on the left bank of the Belan in Meja sub-division of Allahabad district. The triangular celts of the Vindhyas are still waiting to know their real archaeological horizon in the absence of their association with any primary site.

The results obtained from the excavations of the Neolithic habitation sites in the Vindhyas have shed new light on different facets of one of the early agricultural and domesticator communities of India (Sharma et al : 1980). The noteworthy excavated sites are Koldihwa, Pachoh and Mahagara in the Belan Valley (Northern Kaimur), Indari in the Adwa Valley (Central Kaimur) and Kunjhun in the Son Valley (Southern Kaimur).

The early agrarian society of the Vindhyas used fully ground celts and adzes of rounded variety with rectangular or oval cross section. Sedentary settlement is evidenced by circular/oval hutments demarcated by postholes on the periphery. Big sized basin shaped querns with heavy use marks, mullers, hammers, anvils, sharpeners, sling balls and bored stones are some of the food processing and food producing artifacts made on sandstone or quartzite. The tool types in microlithic industry are both hunting as well as food producing—blades, backed blades, backed and truncated blades, points, borers, scrapers, triangles, trapezes, lunates and petit tranchet along with big sized chert flakes. The first agriculturist depended to some extent on hunting economy. This is suported by bone arrowheads and sling balls. The animal bones recovered from the excavations are both of wild and domesticated animals—cattle (*Bos indicus Bovides*), sheep/got (*Ovivigueі—caprіae*), deer (*cervidae*), boar (*sus-scrofa*), horse (*Equidae*), tortoise (*Chelonia*), fish and birds. Rice and *sanwa* (millet) were the main grains. Terracotta breads and the shell pendant are the only evidence of their ornaments.

Among the Vindhyan Neolithic artifact-industries connected with food producing and settled economy, the richest industry is the ceramic industry. (Pal 1986).

The pottery is hand made. On the basis of surface treatment the ceramic industry is divisible into four wares—(i) cord impressed ware, (ii) rusticated ware, (iii) burnished red ware and (iv) burnished black ware.

Because of the very special surface treatment and wide distribution in the region the cord impressed ware is one of the most characteristic features of the Neolithic Culture of the Vindhyas.

The cord impressed ware is confined not only to the Vindhyan Neolithic Culture, the ware is also present in the Middle Gangetic Neolithic Culture (Pal : 1983a). Chirand and Chechar in Bihar and Sohgaura in Gorakhpur, Uttar Pradesh have yielded cord impressed pottery in the Neolithic horizon. Some more surface sites in the Basti and Gorakhpur district of Uttar Pradesh are associated with the cord impressed ware. Not only the cording pattern on the external surface of the pots but pottery types are also analogous to the Vindhyan cord impressed pottery.

The cord impressed pottery has been described as a distinctive ware of the eastern Asiatic Neolithic Complex (Sharma : N.D.). In Eastern Indian Neolithic sites, this ware has been found from Daojali Hading (Sharma : 1966) and Sarutaru (Rao : 1977) in Assam. The cord decoration on the pot is very much similar to those of the Vindhyas and the Ganga Valley, though there is some difference in surface colour of the pottery. It is interesting to note that there is some sprinkling of the cord impressed pottery in the Northern Neolithic complex of India as suggested by the excavations of Gufkral.

A look on the distribution map of the cord impressed ware beyond the Indian sub-continent shows that it is widely distributed in different parts of South-East Asia. It has been found in the Neolithic context though having Hobbinian strains from Spirit Cave (Gorman : 1970) and Non Nok Tha (Bayard Donn : 1970) in Thailand, Laang Spien (Gorman : 1971) in Cambodia, Padahlinn (Thaw U Aung : 1971) in Burma, Gua Kechil (Dunn : 1966) in Malayasia. Cord impressed pottery is also reported from China (Chang : 1972). Japan (Clark : 1977), Taiwan (Chang :1970) and East Siberia (Oklandnikov : 1964).

For manufacturing the Neolithic pottery in the Vindhyas the clay is not well levigated. It contains calcium granules and small iron nodules. Rice and millet husk, chopped straw and leaves have been mixed as degraissant in the clay.

The Vindhyan Neolithic pottery is hand made. Palm and finger impressions are still discernible on many of the pots. The surface treatments were imparted when the pots were leather hard. The pots are ill fired and due to organic temper the core portion of the pots is smoky grey to blackish in colour. Except the ware of ochrous or black slip, the pots are generally of matt-red surfaces. The following table shows distribution of different wares at some important excavated sites of the Northern Vindhyas.

	Wares				
Sites	*Cord Impressed Ware*	*Rusticated Ware*	*Burnished Red Ware*	*Burnished Black Ware*	
Koldihwa	367 56.636%	150 22.625%	118 17.[illegible]25%	21 3.785%	656 100%
Mahagara	3981 17.545%	14285 62.957%	3723 16.408%	701 3.089%	22690 100%
Kunjhun	54 80.6%	6 9%	6 9%	1 1.4%	67 100%

Neolithic pottery types (Fig. 1) are very simple. Among the functional shapes mention may be made of bowls, jars, basins, handis, platters and spouted vessels. Decoration is confined only to applique and incised designs. The carinated neck of jars and tubular spouts are made separately and luted to the pots subsequently.

The cord impressed ware may be treated as fossil type of the Neolithic Culture of the Northern Vindhyas. It is of coarse fabric with thick to medium section.

The technique of imparting cord decoration on the outer surface of pots is problematic. One of the probabilities is that it was done by the application of cord wrapped paddle on the leather hard surface of the pots. Bowls and basins are cord impressed on the whole outer surface but in the cases of jars and handis the neck portion is devoid of cord impression. Presumably the material from which this cord pattern was done was hard enough to provide the cord impression on the concave neck portions. The close observations of the prominent and deep impressed designs raised doubt whether it is really cord-impression or some thing else.

While excavation at Koldihwa was going on in 1974, a fragment of tortoise bone was found from the Neolithic level. The bone piece was so much covered with mud that it looked cord impressed potsherd instead of tortoise bone piece. On the basis of this sudden discovery the author thought that the so called cord impressed ware may be really tortoise shell impressed pottery. For self satisfaction the author made the impression of this bone on a wet clay clod and surprisingly enough it resembled very much to the cord impression. Encouraged by this result some more practical archaeology was done on the technique of cord impression. Plates of tortoise bone were collected from the river bed and some pots—jars and bowls were made. When the pots were leather hard those tortoise bone plates were used as dabber and satisfactory results were obtained. This study indicates that the Neolithic cord impressed pottery is a tortoise shell impressed pottery. But the employment of cord wrapped paddle for imparting the cord decoration on some of the pots cannot be totally ruled out.

The cording on every pot is not of the same nature. These impressions vary from thick to thin through medium and deep to dull and indistinct. The cording strokes are vertical, horizontal, oblique or slanting and occasionally multi-directional.

Due to the burning of the organic temper in the pots and ill firing the core of the pots is blackish, smoky grey or dull matured. The surfaces of pots also vary from mattred, dull yellow to smoky blackish.

Among the functional pottery shapes of the cord ware mention may be made of convex, straight or tapering sided shallow and deep bowls, flat bowls or platters, tubular spouted bowls and straight, concave or carinated necked jars and handis.

Is the cord impressed ware, present at some of the Mesolithic sites of the Vindhyas viz., Morahana Pahar, Baghai Khor, Lekhahia and Ghagharia the result of contact of two cultures—Mesolithic and Neolithic or did the Neolithic cord impressed ware originate from the Mesolithic cord impressed ware ? The Kaimur rock shelters have been places of casual visit of the people even upto early historical period and these have been shelters even today to the cattle grazers. On the basis of early date of 6th-5th millenium B.C. for Vindhyan Neolithic it may be presumed that the cord impressed ware found in the Mesolithic rock shelters is result of interaction between the two contemporary cultures.

But on the other hand, clay preparation for manufacturing the pots, firing condition and state of preservation of the Mesolithic cord impressed ware indicate that it is very primitive in comperision to the Neolithic cord impressed ware.

For dating of the Neolithic culture of the Vindhyas the three dates from Koldihwa reading 4530±185 B.C. (PRL 101), 544±240 B.C. (PRL 100) and 6570±210 B.C. (PRL 224) are dependable and on the basis of these dates the Vindhyan Neolithic is dated to about 7th-6th millennium B.C. The Ganga Valley Neolithic Culture is dated to 2nd millennium B.C.

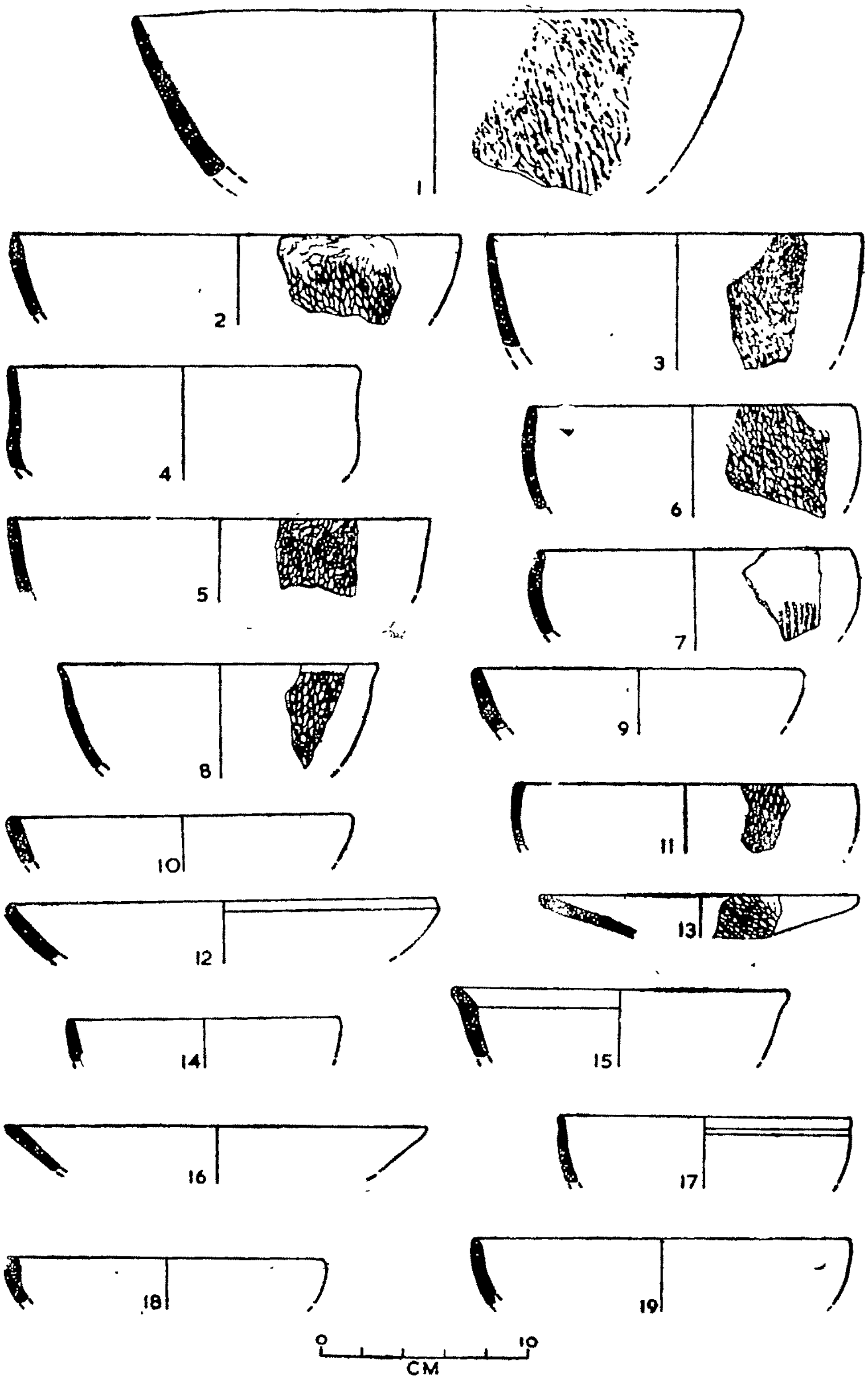
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Fig. 1. Cord impressed ware types

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Sedentism : Problems and Issues

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INTRODUCTION

The history of mankind is broadly divided into two major stages : (i) of the 'hunters and gatherers' of the Palaeolithic, and (ii) of the 'food producers' of the Neolithic. It is generally believed that sedentism, appeared in the Neolithic as a by-product of agricultural activities. In the present paper attention has been drawn to the fact that sedentism is a gradual process and an evolving cultural phenomenon that starts from the Palaeolithic itself.

There are only a few good publications, on the subject; these are as follows. Braidwood and Willey's (1962) *Courses Toward Urban Life* ; Richard B. Lee's (1972) "Prehistoric population Growth and Beginnings of Sedentary life among the Kung Bushman" and Flannery's (1972) "The origins of village as a settlement type in Mesoamerica and the Near East : A comparative study." Other secondary sources are Hassan (1977) "The Dynamics of Agriculture Origins in Palestine : A Theoretical Model" ; Reed (1977) "A Model for the Origin of Agriculture in the Near East", Binford (1968), "Post-Pleistocene Adaptations" ; Redman (1978), *The Rise of Civilization : From Early Farmers to Urban Society in The Ancient Near East* ; Cohen (1977), *Food crisis in Prehistory* ; and Caldwell (1977), "Cultural Evolution in the Old World and the New, leading to the Beginnning and Spread of Agriculture." However, these studies focused their attention on domestication of plants and animals ; sedentism was only of marginal importance to them.

APPROACH

Sedentism has been defined neither anthropologically nor archaeologically. The evidence of sedentism is often offered in the form of structural dwelling, large cemeteries, shell-middens, etc. Sedentary societies have been divided on the basis of mobility into six types—nomadic bands, semi-nomadic communities rotating settlements, semi-sedentary settlements, impermanent settlements and permanent settlements (Spradley & McCurdy 1975 : 191). In other words human settlements vary along a continuum of mobility that ranges from nomadism to sedentism not in the water-tight compartments of time but in the framework of cultural forms.

Sedentism involves permanent settlement in permanent structures round the year. However, the presence of permanent structures does not necessarily indicate permanent settlement. Hassan (1977) points out an interesting distinction between the permanent structure and permanent settlement. He observes that since permanent structure (occupied occasionally by transhuman pastoralists) demarcates the boundary of ownership rights, used for storage purposes and for permanent non-transportable food processing facilities and, permanent settlement involves a whole year residence in permanent structures. He, therefore, doubts if the Natufian structures of the Near East were occupied year long ; they suggest only long term occupation. The Natufian settlements were like 'stellar transitory camps,' mostly used as centres for food collection near permanent structures and seasonal camps. Childe (1936), on the other hand, believed that the introduction of agriculture (his basis for Neolithic Revolution) alone led to the establishment of sedentary communities and permanent year-round settlements. But as noted earlier archaeological records tend to show that the origin of agriculture is not a prerequisite of sedentism. In the Near East and Coastal Peru sedentary communities preceded agriculture, contrary to Mesoamerica where agriculture was followed by sedentism. So is the case with pottery which appeared in the Near East in the Neolithic context. But in the Far East (Japan) and South Asia (India) there are sites, where it appeared in the mesolithic context, much before the introduction of domesticated plants and animals, although it is sometimes held that the people of China and South-East Asia practised incipient food-production, shifting cultivation (horticulture), before they began to cultivate cereals (rice & millet). In any case the earliest occurrence of pottery comes from Japan (Fukui cave 12,500 B.P.), China (Hopeh and Honan province in the Pre-Yang Shao context dated to 6th or late 7th millennium B.C.), North Vietnam (8000–6000 B.P.), Korea (at Tongsamdong, Chado phase, near Pusan contemporary with Early to Middle Joman), Thailand (Spirit Cave, 8800 BP), Indonesia (at Guwa Lawa, East Java, Mesolithic context), and India (Chopani Mando. Belan Valley, Advanced Mesolithic phase, 8080±115 B.P.), Moreover, the initial Joman phase of Japan (12,500–8000 B P) yielded pit-dwellings and Chopani Mando (India) yielded round huts raised on posts. Thus, at the present state of our knowledge sedentism appears to be a need-based phenomenon localized and not universal, and also not a product of diffusion from any nuclear area.

According to Flannery (1972 : 28)

"The origins of sedentary life had more to do with the installation and maintenance of permanent facilities, and the establishment and maintenance of hereditary ownership of limited areas of high resource potention."

According to Hassan (1977 : 595)

"The development of storage facilities which provided a source of food supply at one given place for long time period must have encouraged long-term habitation and large residentil units."

According to Watson and Watson (1969 : 93-94) :

Advanced hunters and gatherers are nomadic to the extent required by the animals they hunt and the plants they collect, but they are semi-sedentary according to the seasonal life cycles of these animals and plants. . . ; semi-sedentary life provides regular intervals of leisure and the time and space for experimentation.

According to Cohen (1977 : 83) sedentism occurs because of the following reasons : (1) decline of resources associated with other parts of the traditional annual cycle ; (2) territorial impingement by other groups ; (3) closely linked with the utilization of broad spectrum resources and (4) it is a response to population pressure and independent from food production. Harris (1977) points out that the emergence of sedentism and population growth are due to the changes in terminal pleistocene environment and subsistence pattern. Reed (1977 : 550) collected some evidence from the Near East which shows that the (1) people were not only reaping and milling grains but also threshing and storing for later use ; (2) population was increasing and each group lived increasingly in lesser area for food-support, and (3) storage of grain led to a more sedentary way of life. Binford's work on Eskimo and Lee's study on Kung Bushman tend to show that there exists a causal relationship between reduction in mobility and population growth. Binford (1968) observes that although certain traits, such as pottery, agriculture, etc., are functionally linked to sedentism, the basic point is the exploitation of broad range of resources which resulted in the increased time consumption on food search and frequent residential visits. Owing to this, small families remain together for longer periods of time which led to the increase in population growth and reduced female mobility. Lee (1972 : 329) however, raised three questions : (1) what are the factors which regulate fertility in hunting/gathering condition ? (2) How the balance of first factor is altered by a shift from nomadic to sedentary way of life ? (3) What is the causal mechanism involved in the alteration of Bushman fertility ? He answered (1) birth spacing is a key factor in a shift from hunting/gathering to a sedentary way of life ; (2) long location suppresses ovalation in Bushman women and birth space interval increases to four year ; (3) long lactation in hunting/gathering societies is due to non-availability of soft, easily digestible food, especially milk.

From the above observations it becomes apparent that sedentism is a cultural process along a continuum of mobility and a product of a long cherished human behavior. However, it may be seen that no single theory explains the phenomenon of sedentism completely since each one has high lighted one factor or the other. As the evidence at hand shows, somewhere sedentism may have appeared as the by-product of 'limited areas of high resource potential' somewhere as the by-product of 'development of storage facilities', and somewhere as the by-product of the behavior pattern of the animals the people hunted and the breeding peculiarities of the plants from which food was collected. In other words, sedentism appeared differently at different places.

FACTORS FOR THE GROWTH OF SEDENTISM

(a) ENVIRONMENTAL FACTORS

There are certain factors responsible for the development of sedentary societies. The most important factor is environment. Environment affects the living patterns in three ways (Cranstone 1972) : (1) need for shelter from rain, cold, head and predators ; (2) need for dwelling, i.e., portable or permanent by affecting subsistence pattern ; (3) provides raw material for shelter and dwelling construction. Owing to the fluctuation in Pleistocene environment, man's socio-economic needs also fluctuated. The nomadic hunters and gatherers tried to adapt themselves in these unpredictable environments by various technical innovations. Interestingly enough, during the Early Pleistocene period biological changes in the hominid were also taking place, increasing his brain capacity, the capacity of limbs—erect posture, bipedalism, opposable thumb, dexterity and behavior. These changes were important for man to develop such a complex network of culture in which he lived now. But the changes were so slow that man for a very long time remained hunters and gatherers, i.e., in 'cultural homeostatis'. It, therefore, becomes clear that during the Early Pleistocene climatic conditions two kinds of evolution were going on simultaneously—biological and behavioral.

During the post-pleistocene period biological changes came to a standstill but environmental changes resulted in the world-wide rise in sea level, warmer climate, extinction of migratory megafauna, exploitation of broad spectrum resources and adaptation to forest and waterside environment. Although, such climatic changes occurred in the pleistocene period also, yet now the change meant a lot to human adaptation : it led to the complete alteration in subsistence strategy, settlement pattern, demographic pressure and technical and cultural advancement. Nevertheless, it did not altogether wipe out hunting and gathering but certainly paved the way for the coming agricultural economy, or Childe's 'Neolithic Revolution'. These climatic changes effected the mobility pattern in different areas of the world in different ways. Man began to live in natural caves and rock-shelters wherever available, and also in open-air sites by constructing living floors, wind-breakers (Olduvai Gorge Bed 1), simple huts raised on bamboos posts and equipped with hearths (Terra Amata—De Lumley 1960), and in pit-dwellings (Kostenki, Dolni Vestonice—Klima 1962), etc. Thus it appears that basically the human nature is to settle down. It was perhaps need based, for example, long breeding periods and insecure food. Sedentism as a need-based phenomenon is Early Pleistocene the post-pleistocene adaptation added nothing new, it only accelerated this process not only by itself but in complete harmony with other cultural systems. Thus, the point at issue is not the inherent human nature of settling down, but the degree and rate of sedentism achieved over a period of time as a cultutral phenomenon in a human group.

(b) SOCIAL AND CULTURAL FACTORS

The second factor is related to social and cultural innovations. These innovations have great influence on the living conditions of man and his socio-cultural life. Culture complexity increased from the Middle Palaeolithic through the Upper Palaeolithic and this can be measured by the presence of different kinds of specialized tools, cave art, burial practices, hunting techniques, personal ornaments, human figurines, storage pits and permanent settlements. During the Mesolithic or Proto-Neolithic period, hunters and gatherers invented different kinds of tools (pestles, mortars, sickles, harpoons, bow, arrow, canoe, etc.) to exploit broad spectrum resources, mostly locally available. These innovations reduced the degree of mobility and increased the opportunities of life at one place for longer periods of time than ever before. These people built permanent structures, although there is hardly any evidence to prove if they had occupied it seasonally or year-round. However, on the basis of the presence of a number of structural dwellings, often more than six, in the Near East, it appears that the Mesolithic people lived there permanently for almost whole of the year. Binford (1968 : 335) is also of the same opinion but Hassan (1977 : 595), as mentioned before, thinks otherwise. For him the Natufians were semi-sedentary even though their settlements had larger number of houses because so far we have no evidence of plants and cereals from these settlements ; and in his view, sedentism goes hand-in-hand with agriculture. Whatever may be the fact the degree of mobility was highly reduced. The succeeding Neolithic people, along with their heavy food-processors, made different kinds of tools (ground axes, hoes, etc,. to meet their needs of agricultural activitis. They built stone walls around the settlement (Jericho, Kenyon 1954) for defense purposes, built large residential complexes on grid plan (Catal Huyuk, Mellart 1964), practised religion (Jericho & Catal Huyuk shrines), engaged in trade (Armenian obsidian—Catal Huyuk, Cayonu Bouqras, Tell Shemsharah, Jarmo, Sarab, Tepe Guran and Ali Kosh ; Anatolian obsidian—Hacilar, Catal Huyuk, Cakrine, Mersin, Asikli Huyuk, Jericho, Beidha, Tell Ramad, Ras Shamra, etc.—Dixon, Cann & Renfrew 1968), and made small copper objects (Cayonu, Shanidar and Mehrgarh). With the adoption of a different subsistence base, meat eating, there appeared a sexual division of labor. Women and children spent their time on collecting fruits, nuts and tubers, and man engaged himself in animal hunting. Hunting also facilitated the need for tools, cooperation, sharing, planning, knowledge and skill. Man innovated shelter, fire, clothing, cave arts, burial customs and other items (terracotta figurines, etc.). His main social activity was possibly to sit around the fire in the evening and share experiences.

Thus, from the Palaeolithic onwards, man was adding someting or the other in his cultural milieu, and making his social life more complex on which he depended increasingly more and more. In other words, man parasited himself by his own innovations by generating needs, which in turn led to other needs, and that process is still continuing. Through time, the degree of mobility was reduced to the extent that man began to associate himself with the land he inhabited, generally near rivers and lakes. Since natural shelter were not available, he built huts to sleep and carry out his daily social activities without any danger from nature, such as rain and cold and even predators, and to store foods for a long period of time. The evidence from the Belan valley and the Ganga valley is conclusive in favour of protection as the main consideration for constructing huts (Sharma 1980). The same people who built huts and cattle pens in the Belan valley, for example at Chopani Mando (9th millennium B.C. Advanced Mesolithic site) and Mahagara (7th-8th millennium B.C. Neolithic site) lived in open-air sites (on dry elevated lake beds surrounded by water) in the Ganga valley, for example at Sarai Nahar Rai and Mahadaha. However, Prof. Sharma (1980) thinks that the settlers of Chopani Mando were only seasonal migrants. In any case the basic features of sedentary societies were already established during the Palaeolithic period. Other features, such as kinship relation, family unit and hereditary ownership rights to house, agricultural land, band, water, etc., appeared later, stage by stage. During the Advanced Neolithic period, division of labor was diversified. There were stone workers, potters, traders, metal workers terracotta modellers, chiefs, farmers and possibly priests, although in the beginning there was perhaps no rigid exclusiveness of professions ; one person combined in himself several items, though not all. This complex network of interdependency of peoples specializing in different fields resulted in the elimination of mobility in a big way and, thereby, establishment of sedentary societies.

(c) SUBSISTENCE FACTOR

The third important factor is the nature of subsistence which had far greater effect on the mobility pattern of prehistoric societies. During the Pleistocene, environmental changes directed man's mobility, which was the result of his search for food, by changing the availability of food supply from one region to other. However, evidence at hand indicates that there were always certain areas where food resources might have been available for most part of the year and in such areas man did build occupation floors (Olduvai Gorge Bed I) or lived in caves (Choukou Tien, Bhimbetka, etc.). Whether he lived at these sites seasonally or permanently is not fully known, although on the basis of subsistence pattern (hunting/gathering), it appears that they were not sedentary. It is also indirectly supported by the ethnographic studies made in different isolated areas of the world. But in tropical East Africa, where the environmental condition was so favourable and water was available in the lakes. there was hardly any need for the early man, like the *Homo habilis*, to build structural dwellings. The huge depression of the lake was enough to protect him from the predators, as we know that the inhabitants of the plain dwellers of Dolni Vestonice and Kostenki, or even the people of the Initial Joman culture of Japan lived in natural depressions with specific modifications.

From the Lower Palaeolithic onwards hunters and gatherers became selective in the choice of animals for their hunt, a factor which greatly effected their mobility pattern. The Post-Pleistocene environmental changes resulted in the extermination of a number of Pleistocene flora and fauna as a result of which man began to exploit what is generally called 'broad spectrum resources'. Flannery (1969 : 77) points out that this need of broad spectrum resource utilization was felt even during the Upper Palaeolithic (20,000 B.C.) when man for the first time depended largely on fish, crabs, water turtles, molluses, land snails, patridges, migratory water fowl (and wild cereal grain in some areas ?), but still the large percentage of energy that he received came from herd animals. This broad spectrum resource utilization was increased in the Post-Pleistocene period and continued upto 6000 B.C. Flannery (1969 : 77-79) feels that this change was not only due to environment alone, although, it contributed considerably to the development of storage facilities and division of labour. Before agriculture became widespread there was an era of incipient cultivation or the use of the wild variety of cereal grains available in the Near East, or incipient horticulture of *taro* and *yam* based on slash-and-burn (shifting cultivation) technique in China. Pestles, mortars, pounders, querns, sickles, etc., have been found at most of the sites preceding agriculture. It indicates that some grain processing activities (threshing, winnowing, grinding, etc.) were going on in the Mesolithic period. Because of the permanent storage facilities, the availability of a wide variety of foods locally, heavy pestles and mortars and population growth man's degree of mobility was reduced to the minimum.

(d) POPULATION FACTOR

The fourth factor is population growth. It is somewhat difficult to measure population growth from archaeological records although it can easily be made out from the progressively increasing number of sites and thickness of deposits that Middle Palaeolithic onwards there has been definite increase in population. Cohen (1977 : 78-83) measures population growth on the basis of the presence of not only number, extent, depth of occupation period of sites, but also occupation of new areas, use of microniches (desert, coast or forest), shift towards more ecletic food gathering patterns, concentration on water based resources, shift from large animals to small animals, beginning of food preparation, specialized tools, bones of large number of hunted animals, origin of burial custom, cave arts, and other non-utilitarian activities, etc. He further observes that population pressure might force human population, either to begin relatively rapid movement or to assume sedentary posture, depending upon the distribution of population and resources. On the hilly flanks, due to the seasonal migration of resources, population pressure may lead to the utilization of secondary foods, development of storage facilities and ultimately settling down. Moreover, population growth restrict woman's mobility and transporting capacity, the ultimate solution of which is to settle down. As mentioned before, Lee's (1972) study among the Kung Bushman of Botswana indicates that reduced mobility in woman shortens birth spacing and increases population. However, population growth reduces woman's mobility by overgrowing children and shortening birth spacing. In hunting/gathering societies high natural fertility is maladaptive for both mother and child because long lactation suppresses ovalation which automatically increases birth spacing and no increase in population. To the contrary, sedentary life removes these resistants by making available soft and easily digestable food (milk, mush, etc.) for weaning and thus, reducing long lactation and increase in population (Lee : 1972 : 338-340). Ethnographic studies have shown that there is some other mechanism also which is responsible for causing no change or increasing in population, in hunting/gathering societies, viz., high mortality rate, abortion, infanticide, malnutrition, epidemic disease and killing. Although, these factors kept on working in sedentary societies also, yet is also eliminated certain basic restrains of food search, protection, cooperation sharing and maintenance of unproductive members (old, cripple, etc.), and basic medicine and surgery. It is, therefore, evident that population growth contributed considerably in the process of sedentism,

INTERPRETATIVE MODFLS

Carl Sauer (1952), Hawkes (1969) and Harris (1969) have developed an 'ecological system' approach which explains the symbiotic relationship between man and his environment and the role of incipient food production in that relationship. They have also provided somewhat predictive statements as to which areas might be expected as the birth place of plant domestication. Although, it is an interesting model yet it does not provide what cultural mechanism is responsible for change from collecting to producing (nomadic to sedentary) society. Kent Filannery (1971), on the other hand has applied 'systems theory' in his work on Mesoamerican sites. He maintains that the total cultural system is composed of different subsystems all of which are related to each other and with environment. All such subsystems can be compared and interpreted on the basis of two basic processes : centralization and segregation, both of which have positive and negative feedback. This model has two basic flaws—first, not much is known about the link connecting these subsystems, and second, correct identification of the total components of such systems is quite difficult. Basically, this model makes general statements of large scale events, e.g., emergence of civilization and growth of cities, but as knowledge of components of systems increases this model may also explain sedentism as a product of complex network of cultural subsystems. In this connection Binford's 'equilibrium model' is quite helpful. It shows that two factors are responsible for culture change—first is the disequilibrium caused by physical environment, and second demographic pressure. This model, therefore, explains the processes of culture—change and factors responsible for change in man's way of life from hunting/gathering to sedentism. 'Locational model', applied on both local and regional scale, explains sedentism in general and settlement pattern in particular. It explains not only the selection of sites but also the spread of 'daughter' settlements around earlier sites. (Hodder 1980). In this connection, the concepts of 'catchment area' and 'place theory' (Binford 1982) are extremely helpful in our efforts to understand subsistence and settlement patterns which is necessary in order to determine which ecological zones were being utilized, on seasonal or year-round basis if possible. There is yet another significant model, called 'economic model', which is based on the modes of subsistence and recovery of food residue. It explains the availability of plants and animals in different ecological zones in different seasons and the adoption of a kind of strategy 'socio-cultural and technological for the acquisition of those available food resources. The availability of food will determine the nature of their settlement, i.e., autumn camps, dry season camps, spring camps, seasonal camps, or long term or permanent camps (Dennel 1980).

On the basis of ethnographic studies models for social organization have been proposed to understand the structures of past human societies. Fried (1967) and Service (1962) divided the society into *simple egalitarian, ranked, stratified* and *state* and, *band, tribe, chiefdom* and *state*. Although it is difficult to understand the level of social organization from the material culture, yet good guesses can be made in this direction on the basis of architecture and grave-goods.

According to Redman (1978 : 205)

> "The difference between bands and tribes was both demographic and economic. Pleistocene hunting-and-gathering communities were organized as egalitarian bands. The transition to tribes may have accompanied the growth of villages composed of rectangular architecture. However, some of the larger Natufian sites such as Mallaha (stage 2), must have had tribal organization. Village farming sites, such as Jarmo, Beidha, Munhata, Ali Kosh and Hassuna, were probably all egalitarian communities. There is no strong evidence for craft specialization, or for significant status or economic differentiation within these villages or between different settlements."

Chiefdoms can also be distinguished from tribes on the basis of the uniformity in pottery types, designs and paintings, presence of rare and exotic items (even children of the chief were buried with material goods), greater population size and density than what characrizes tribes, settlement pattern of chiefdom consists of a ceremonial centre, a large house for chief, large settlements for greater population and surrounding smaller settlements, for the maintenance of the bigger settlement. (Redman 1978 : 205 ff). Service (1962) separates chiefdom from tribe on the basis of specialization and redistribution of material goods. According to Flannery (1972) community organization is also reflected in the types of houses in the two early sedentary communities. He has demonstrated that in the Near East earlier circular houses were replaced by later rectangular houses which reflects perhaps the growth of families, e.g., extended families.

SOME CRITERIA FOR IDENTIFICATION

(1) The presence of structural dwellings, often supplemented by summer huts or open-air settlement.

(2) Use of pise, mud, mud-bricks for house construction. However, it should not be taken as a rule, simple pit-dwellings with sufficient amount of cultural accompaniment are enough to indicate permanent habitation.

(3) The presence of storage facilities, either in pits or pots.

(4) The presence of food processing equipment, viz., pestles, mortars, grinders, sickle, etc., although by themselves they may not indicate full sedentism.

(5) The use of pottery for cooking and storing, although, pottery appeared in Japan before sedentism. In the Near East pottery appeared much after the Mesolithic Natufians had built permanent structures. But that is not to say that pottery was not involved in the process of sedentism. The overall evidence indicates that pottery was extensively used for storing grains which is a major factor in the development of sedentary societies.

(6) The economy, based on broad · spectrum resource utilization, including wild variety of wheat, barley, rice, etc. and later domestication of these items on selective basis.

(7) The presence of family units, primitive kind of hereditary ownership rights, craft specialization, religion (shrines) and some form of trade.

These criteria, it is hoped will help us in visualizing sedentism as a cultural phenomenon. It is a gradual process and has to be viewed along the continuum of mobility, i.e., the degree of mobility achieved at a particular point of time : it ranges from nomadic through semi-sedentary to sedentary. The basic causes of sedentism might have been changes in subsistence pattern and population pressure, but other causes, such as environment and techno-socio-cultural, etc., were also major stimulants in the process of sedentism. In it even the element of protection with the help of structural walls of one kind or the other is also an important consideration. Structural dwellings, alongwith storage facilities for cereals such as bins and barns, and food processors, such as pestles and mortars are, of course, the most developed items to establish sedentism at an archaeological site. However, settlement pattern is viewed as the prime factor in identifying sedentary societies than the subsistence pattern or population.

ADVANTAGES AND DISADVANTAGES

ADVANTAGES

(1) reduction in mobility.

(2) cuts labor costs and eliminates basic restraints for food search.

(3) It allows accumulation of capital goods, for example land, houses, and precious and semi-precious objects.

(4) provides protection, cooperation, sharing and maintenance of unproductive members of the society (old, cripple, sick, etc).

(5) Growth of population.

(6) It provides leisure for experiments in medicine and surgery, art and architecture, modelling and agriculture.

(7) Social, cultural, religious, technological and commercial (trade) developments.

DISADVANTAGES

(1) It creates problem of collection of food resources from the limited types available locally.

(2) High labor costs in food processing and preparation.

(3) Problem of the storage of cereals and prepared food.

(4) Loss of stored food by rodent and rotting.

(5) Increase in morbidity and mortality rates, malnutrition, epidemic disease, infanticide, abortion and killing.

(6) Exploitation of human labour and enslavement.

(7) Clash over land, water, and other valuable items within and from outside.

CONCLUSION

Thus we see that the prime factor of sedentary way of life, structural dwellings, is present throughout the human history, from the Lower Palaeolithic through the present but difference in number, size, quality, occupation period and distribution of structural dwellings indicate that Palaeolithic hunters and gatherers were not sedentary but nomadic, that too also to the extent of the availability of plants and animals according to their seasonal life cycle. Sometimes their camp was rotatory as hunters and gatherers of Terra Amata came there again and again a least nine times. The evidence from Dolni Vestonice, which was also complemented from the summer huts built overground, indicates that hunters and gatherers of the Upper Palaeolithic spent their winters in pit-dwellings and summers in open-air. They were sedentary only to the extent the food resources were available, round the year or part of a year. During the Mesolithic, they built huts to be used by individual persons basing their economy on the collection of broad spectrum resources, including wild wheat and barley. The Neolithic witnessed the emergence of rectangular huts cluster (two or three huts grouped at one place) together at different localities of the settlement, which appears to have been used by each family unit. Natufians of the Near East were sedentary, although in other parts of the world, for example Japan and India, the settlements in the Mesolithic were still seasonal. Recent archaeological research at Aq Kupruk, in Northern Afghanistan, and Mehrgarh, in Baluchistan, have shown that besides Fertile Crescent there are sites where sedentary settlements flourished during the pre-pottery Neolithic. About Mehrgarh (7th millennium B.C.), the excavator observes: The architectural remains reveal a stage of already well developed settlement with rectangular multiroom houses built with mudbricks. (It) indicates the permanent character of the village (Jarriage & Lechevallier 1979 : 471).

The evidence from Aq Kupruk is also interesting. Here both the Aceramic and the Ceramic phases of the Neolithic have been found. The ceramic is further divided into Phase A and B. Phase A (8000 B.C.) yielded the remains of domesticated animals (sheep, goat, cattle, etc.) and a few hearths and floors as well as stone hoes, celts, querns, etc. Gupta (1979 : 10) thinks that this picture represents a very early stage of settled life, depending on the collection of wild cereals and domesticated animals. This is the herding stage. The evidence from Belan valley has also indicated that domestication of plants (rice-Koldihawa and Mahagarha, dated to 6570 ±210 B.C.) and animals at a very early stage of Neolithic. At Mahagarha the evidence of cattle-pen has also been found. Significantly, it was surrounded from all sides by huts (Sharma 1980).

The total picture that emerges is, therefore, as follows : instead of one Fertile Crescent, there were at least five major zones of early sedentism in the Old World, viz., Levant, Anatolia, Zagros flanks, Northern Afghanistan and Baluchistan, and the Belan valley. Although, early houses have also been constructed at Joman phase in Japan yet it appears to have a case of seasonal sedentism which fully developed only during the Middle Joman period. In India even in the third millenium B.C. when the Harappan Civilization was in its hey day, there were certain communities in Kashmir, for example at Gufkral and Burzahom, which lived in pit-dwellings. The Aceramic pit-dwellers of Gufkral did not domesticate plants or animals, instead subsisted on wild plants and animals (Sharma 1982) alone. This may demonstrate that the people took to agriculture quite late, possibly as a result of interaction with the pottery using communities, at least in some areas. Finally, it is hoped that this excercise will help in visualizing sedentism as a major area of cultural inquiry from the Palaeolithic to the present. The origin and development of sedentary societies cannot be properly understood unless and until it is viewed as an evolving cultural phenomenon based on the continum of mobility pattern of the past societies.

ACKNOWLEDGEMENT

I am extremely grateful to Prof. (Dr.) Gregory L. Possehl. my academic Advisor, for going through the manuscript and giving me valuable suggestions and also for providing me an opportunity for discussion in spite of his busy schedule. I am also thankful to my friend Mr. John W. Lawrence for encouragement and valuable suggestions.

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Probability Sampling in the context of the Stone Age of the Satna District, M.P.

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There are two types of field techniques in archaeology, first—exploration or survey, and second—excavation or digging. Under the first technique archaeologists explore or survey the region for places (sites), where people once lived or carried out special activities, and/or geomorphological features to know about palaeo-environment of the region and try to correlate surface findings in terms of spatial analysis. In the second technique archaeologists excavate or dig the place (s) to know about settlement structures, behavior and subsistence in terms of different cultural phases or periods of his surface findings. Thus, exploration is a two dimensional technique, while 'excavation is a three dimensional technique' In this research only first technique, has been followed based upon the probability sampling procedure.

SAMPLING

For complete or nearly complete and integrated data a well thought plan is, perhaps, the most logical way to begin any archaeological investigation in a given or chosen region. A systematic survey would not only provide sufficient data with multi-spectrum information in minimal resources, but also leave behind an adequate record for future investigation. Needless to emphasise that it is mainly a well thought out exploration project and its implementation with systematic and orderly survey that can provide any controlled data for a preliminary characterization of the regional archaeology. Moreover, the information based upon such data also offers a basis for excavation and further exploration and detailed study in the region on scientifically justifiable grounds.

Long before 1950's workers realised that decisions and conclusions regarding the past history of human behaviour were generally based upon inadequate samples (Kroeber, 1916 ; Spier, 1917, Gladwin and Gladwin, 1928), yet it was only after 1950's particularly under the influence of Vescelius (1960) Spaulding (1960) and others that archaeologists began to regard the word sampling within the mathematically established technique generally known as random sampling. Since 1960's a number of scholars like Binford (1964), Cowgill (1964) Hill (1967), Ragir (1967), Plog (1968). Thomas (1969, 1975), Redman and Watson (1970), Redman (1973 1974, 1975), Judge (1973), Read (1975), Judge, et. al., (1975), Reid, et. al. (1975) have opined that archaeological explorations would yield the most meaningful results if they are done on a regional basis and if other technique of investigating sites are supported by the procedure of 'probability sampling'. Further scholars like Binford (1964) and Redman (1973, 1974) suggested that random sampling should be treated as an integral part of comprehensive theoretical and practical research design. The present author's sampling experiments demonstrated that the informations retrieved by following the probability sampling procedure in the region provided results close to the informations gathered after surveying the whole region (Sinha. n.d.). The probability sampling procedure is the most economical and precise scientific tool to know about the inventory of archaeological sites in the region and this procedure also reduces human biases in the course of collecting artifacts at the site as well as those biases that influence in the formation of sites (Sinha, 1984 : 373-76, n.d.).

Considering various factors the following two types of probability sampling procedures have been applied in this research.

(i) *Simple random sampling* : It is the simplest kind of orderly selected sample. The process of selection of units from the sampled population and/or target population is done by the use of a random number table. The fundamental concept behind the selection of units with the help of random number table is that every sampling unit has an equal probability of being selected. Moreover, this probability is equal to the ratio of the sample to the total sampled population to be investigated. The sampling frame is considered in an undifferentiated manner ; therefore, the probability of being selected is also equal for every combination of units. In practice this involves first of all the counting of the total number of sample units in the sampling frame of the sampled population and then follow the decision about how many units or percentage are to be sampled and/or investigated. For this purpose sampling units are numbered serially and the decided number of units are then selected according to the random number table.

(ii) *Stratified random sampling* : The difference between the simple random sampling and stratified random sampling is that in the latter the total area (region or site) is divided into two or more strata depending upon the situation and an independent random sample is taken from each strat. Therefore, for the selection of random sampling units from each stratum the sampling units of each stratum are independently serially numbered. Further, each stratum can be sampled with equal intensity or can be differentially sampled. The differing population can be taken into account when calculating the mean values.

STRATEGY

The adoption of strategies for archaeological field work paticularly field survey depends upon the considerations of various factors such as the nature of general physiography of the region, the expected potentiality of the area in terms of archaeological material and natural resources, instruments available for survey and the availability of local transport for movement in the region goal and methodology to be adopted in the field work to prove or disapprove hypothesis and, lastly but not the least the availability of financial support for labour wages, lodging, food and travel.

Problems in carrying field work differ from region to region. For example difficulties in surveying a hilly region, full of forest, hillocks, hillgirdle valley and plains such at Satna, Rewa, Sidhi districts of Madhya Pradesh, Central India would be entirely different from those of plain regions such as Kanpur, Pratapgarh, Lucknow districts of Uttar Pradesh, India. Therefore, before going to the field it is necessary to know about the present physiography and topography of the region.

Considering the above and other facts a detailed study of regional survey map of Satna district was done to know the area about hillocks, plains, forest and hill-girdle valleys and the main drainage systems of the district (Sinha, 1981 : 54-64).

The region of Satna district (7541 km^2) is full of hillocks and forests (approx, 2990 km^2), hill-girtly valleys (approx. 3985 km^2) and plains (approx, 566 km^2). Tons river and its main tributary, river Satna, in the study area are the main drainage systems of the Satna district. Therefore, while deciding the sampled population of the study area it is considered that the maximum portion of Tons and Satna rivers, representative portions of all the four administrative divisions and a fair representation of all the three topographical units such as hillocks, hill-girt valleys and plains, must fall within the sampled population. In this research the sampled population and the target population are the same (of. Read, 1975 : 52 ; Chanhall, 1975 : 5).

For the operational planning an area of 10″×8″ was marked on the blue print of the survey sheet (1″=4 mile, survey sheet nos. : 63H, 63D, 64A, 63C) of the district Satna (Fig. 1). This area (10″×8″) was further divided into smaller sampling units each of 1″ square that produced in all 80 sub-units of which one unit falls out side the district of Satna. It has been excluded from our study as well as from the sampled population. Each square covers an area of about 40.96 km^2. Thereafter, each square or quadrate was numbered serially, from no. 1 to 79. The sampling frame of 79

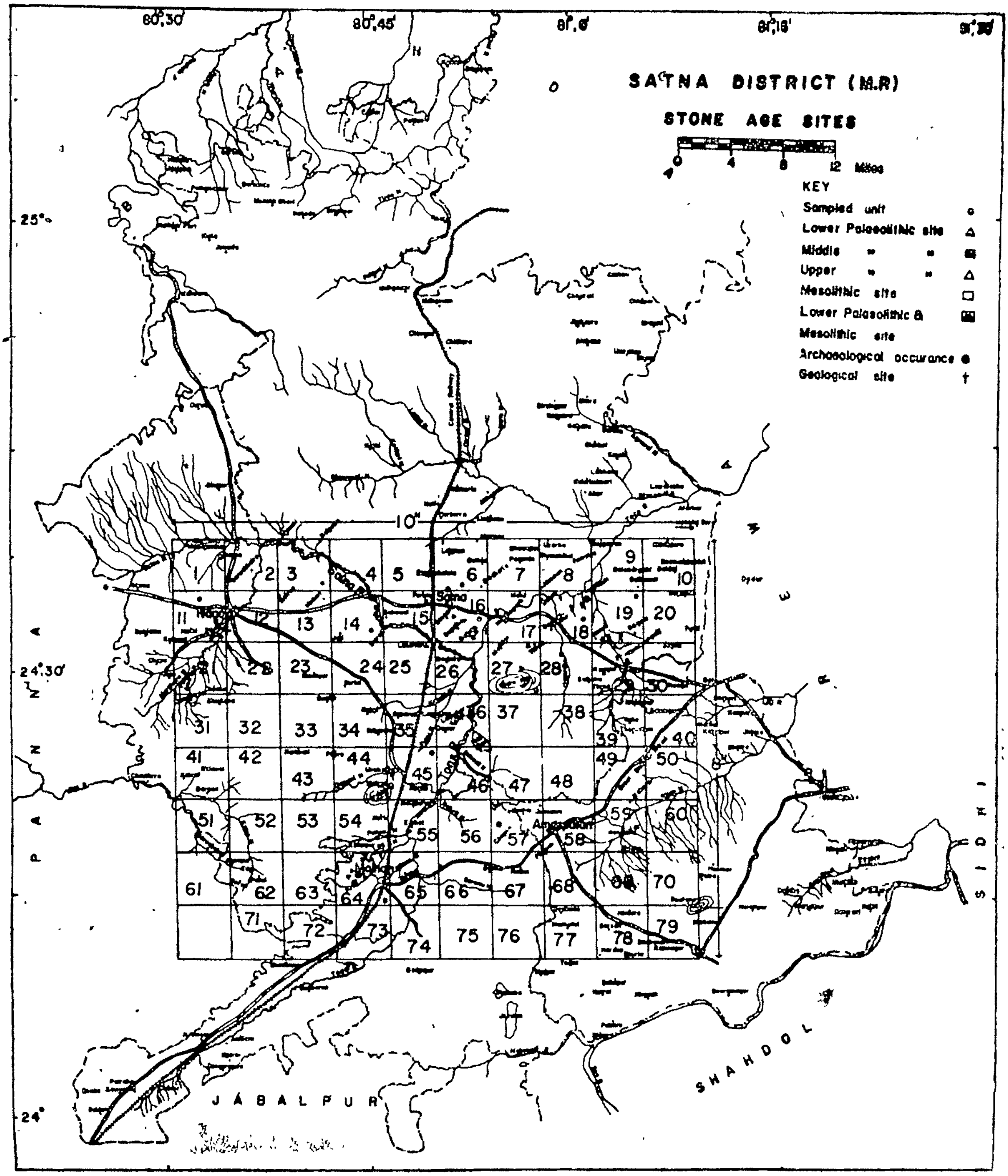
80°30'
80°45'
81°0'
81°15'
25°
24°30' N
24°
SATNA DISTRICT (M.P)
STONE AGE SITES
0 4 8 12 Miles
KEY
Sampled unit ○
Lower Palaeolithic site △
Middle " " ▨
Upper " " △
Mesolithic site □
Lower Palaeolithic & Mesolithic site ▨
Archaeological occurance ●
Geological site †
Satna
Nagod
Amarpatan
Maihar
JABALPUR
SHAHDOL
PANNA
SIDHI

Fig 1.

units covering an area of about 3145 km^2, forms about 42% of the Satna district.[1] This sampling frame represents population which is also the target population in this research. Out of 79 sampling units 12 units corresponding to the random number table (Sinha, 1984 : 51) were chosen. These units (12) forming about 15.6% of the sampled population covers an area of about 491.5 km^2. These samples are 45, 3, 27, 19, 6, 11, 59, 57, 16, 14, 64, and 18. The whole area of selected sample units was surveyed in detail with equal degree of survey (Sinha, 1984 : 26). Each unit was an element of interest, proceeding in the order in which the units were chosen from the sampling frame.[2]

In the course of survey of these sampled units whenever the researcher found any site, the collection of artifacts was made with the assumption that the size of the site represented the sampled as well as the target population. For this purpose the site (sampled/target population) was divided into units with a view to apply either the simple or the stratified random sampling procedure depending upon topography of the site. Each sampled unit at the site was the element of interest. The size of sample units also varied from site to site depending mainly upon the size of the site and its nature.

The determination of the size of the site was governed mainly by the nature of artifacts distribution. The area which has heavy concentration of artifacts at one centre but shows a gradual reduction of the concentration from the centre to the periphery, leading, finally, to the disappearance of the artifacts reprepresents normally the size of a particular site. However, if just a few artifacts reappeared after a considerable gap, then for obvious reasons these were not considered within the area of the site. Such a situation was considered to be just a case of scatter either by natural agency or animals, or any other agency.

PRIMARY DATA COLLECTED

Almost all the sampled units except, 6, 27, 57 and 59 have been extremely rewarding in building a preliminary alluvial stratigraphy of the Upper Tons valley. Alluvial stratigraphy of the Upper Tons valley and archaeological artifacts found within the geological sections at various places have been discussed and interpreted some where else (Sinha, 1984 : 130-53). Here we propose to present only details of each site in relation to those sampled units which provided archaeological sites (Fig. 1). Mention is being made about the probability sampling procedures adopted at each site for the collection of artifacts, size of site, size of sample units, percentage of random sample collected, topography and location of sites. We will proceed in the order in which the units were chosen from the sampling frame and were explored.

Sample 45 (24°21′20″—24°25′ N ; 80°45′—80°49′ E)

This quadrate is bounded on north-east, north-west, south-east and south-west by Sukhi nala, Unchahara-Nagod road, the village Rampurwa and the river Tons, and Kasla Pahar, respectively.

Only one occurrence was found in this sample. It is situated on the slope of Kasla hill near the village Mohari about 2 km south of Unchahara. A few artifacts were present and their distribution was scattered. Therefore, no sample was collected at this occurrence. Though, typologically and technologically artifacts can be placed in the period of Lower Palaeolithic.

Sample 27 (24°28′40″—24°32′20″ N ; 80°53′—80°57′ E)

This quadrate is marked on north-east, north-west, south-east and south-west by the village Tikura, the village Majhiar, Naru hill and Naru hill, respectively. Two sites were noticed within this sample. These are Tikura and Naru hill.

The site Tikura (24°32′ N ; 80°56′20″ E) is situated about 4 km south-east of Madhogarh-Tons bridge and 3.5 km south-west of Sajjanpur-Tons bridge. It is on a high relief weathered rock and relatively in open surroundings. The site is close to the Tikura village and, now a days huts and houses are made on the same height. There is a slight sloping towards south-west. The size of the site is about 24m × 12m and north-south oriented, facing river Tons on the west which is about 6 km from the site. At one place towards the south of the site about at a distance of 60m a small trench was dug by some local people which reveals that on the weathered folded rock is present a brownish red shale deposit of 20 cm thick. Over this deposit is a yellowish red clay deposit of 15 cm thickness. This is capped by a thin humus layer of about 10 cm. Probably artifacts are associated with yellowish red deposit. The distribution of artifacts is not even and have a thin patination. Most of the artifacts are fresh and slightly abraded. Topography and physical condition of the object suggest primary context nature of the site. Following the simple random sampling procedure, the site was divided into 4m×4m squares which produced 18 sampling units. Out of which about 11·1% sample was collected through two random sample units—11 and 9 which consisted of 11 and 8 artifacts, respectively. Hence, the total artifacts collected at the site was 19. The artifacts are made on quartzite and only a few boulders/cobbles are present close to the site. Typologically and technologically this site can be classified into Lower Palaeolithic period.

The site, Naru Hill (24°31′20″ N ; 80°55′10″ E) is situated on the foot of Naru Hill and about 6 km south of Madhogarh-Tons bridge. The site is not on a high relief weathered rock rather relatively on a low relief weathered rock just on the foot of the Naru hill present on south of the site It is about 5 km east of river Tons and about at the same distance west of the river Magardha. The site has been disturbed unknowingly by Civil Engineering Department in the course of constructing a road of about 2·5 m wide. Therefore, on the basis of available size of the site the sampled population or size of the site is 30 m×4 m and 20 m×2 m and south-north oriented. The physical condition of most of the artifacts is fresh and slightly abraded, though a few moderate and heavily abraded artifacts are also present. The distribution of artifacts is relatively even and have a thin patination. Like the site Tikura, artifacts are associated with yellowish red deposit. The topography of the site and physical condition of artifacts suggest primary context nature to the site. The artifacts are fashioned on quartzite and the raw material in the form of boulders/cobbles is available close to the site. As the situation needed the stratified random sampling procedure was used and, the site was divided into two strata—I and II on the right and left side of the road approaching hill, respectively. The available size on the right side is 30 m×4 m (stratum I) and on the left 20 m×2 m (stratum II). These strata were further divided into 2 m×2 m quardrates which produced 30 and 10 sampling units, respectively. Out of each stratum an independent random number for 10% sample was selected. These random simple units were 5, 18 and 21 in the stratum—I and sample unit 3 in the stratum—II. Sampled units of stratum-I consisted of 11, 10 and 8 artifacts, respectively while sampled unit 3 of stratum—II consisted of 10 artifacts. Thus, a total of 39 artifacts collected at the site. Typologically and technologically this can be placed into the period of Lower Palaeolithic.

Sample 19 (24°32′20″–24°36′ N; 81°1′—81°5′ E)

This quardrate is bounded on north-east, north-west, south-east and south-west by outer boundary of the village Gathawar, the Nat nala in the village Hinouti, the village Sagoni and the village Nimua, respectively. A total of three sites is present in this sample. These sites are Nimua, Sagoni I, and Sagoni II.

The site, Nimua (24°32′30″ N; 81°1′30″ E) is situated about 2.5 km north of Satna-Rewa road and 0.5 km west of Nat nala. The exposed surface reveals that artifacts are lying on the flat surface of yellowish cemented silt of $CaCo_3$ and almost in open surroundings. This deposit is capped by a humus layer of 20 cm thick. The artifacts are fresh and most of them heavily patinated suggesting thereby a primary context nature to the site. The distribution of artifacts is not even. The exposed size of the site is 8 m×2 m and south-east oriented. Following the simple random sampling procedure it was divided into 1 m×1 m quardrates which produced 16 sample units. Out of that about 12.6%, 2 random sample—7 and 14, was collected. These sampled units consisted of 19 and 13 artifacts, respectively. Thus, a total of 32 artifacts was collected. Mostly artifacts are made on chert. The source of raw material was, perhaps, river beds. Typologically and technologically this can be placed into the period of late Upper Palaeolithic, as such type of artifacts have been classified in Indian context into the said period.

The site, Sagoni-I (24°32′20″ N ; 81°3′ E) is located on the right bank of Nat nala and about 3.5 km north of Satna-Rewa road in the village Sagoni. It is situated on a low mound relatively in open surroundings. The exposed area shows—at the bottom there is a deposit of about 20 cm thick yellowioh red silt containing a few CaCo3 nodules which overlain by a 15 cm blackish sandy slit and the latter is capped by a 15 cm layer of humus. It appears that artifacts are coming out of blackish sandy silt. The artifacts are fresh and patinated. The distribution of artifacts is not even. Topography and the physical condition of the artifacts suggest primary context nature of the site. The size of the site is 6 m × 3 m and south-east oriented. Following the simple random sampling procedure it was divided into 1 m × 1 m squares which produced 18 sampling units. Out of these units about 11.1% sample, i.e. 2 sample units—17 and 9, was collected. These two sampled units consisted of 115 and 39 artifacts, respectively. Thus, a total of 154 artifacts was collected. The source of raw material was probably river beds. Mostly artifacts are made on chalcedony, agate, chert and carnalian. Typologically and technologically it can be called as Mesolithic site.

The site, Sagoni-II (24°33′ N ; 81°3′ E) is situated about 100 m north of Sagoni-I. It is also on a low mound and relatively in open surroundings. The exposed section revealed almost similar picture as found at Sagoni-I. The physical condition of the artifacts is fresh and patinated suggesting thereby primary context nature of the site. It is also south-east oriented mound site having 4 m × 5 m dimension. The distribution of artifacts at the site is even. Following the simple random sampling procedure it was divided into 1 m × 1 m sample units which produced 20 sampling units. Out of that 10% sample (2 random sample units—5 and 18) was collected at he site. Sampled units comprised of 60 and 48 artifacts, respectively. Thus, a total of 108 artifacts was collected at the site. Mostly artifacts are fashioned on chalcedony, agate, chert and carnalian. Probably the source of raw material would have been the river beds. Typologically and technologically this belongs to Mesolithic period.

Sample 11 (24°32′20″—24°36′ N ; 80°30′—80°34′ E)

This quardrate is marked on north-east, north-west, south-east and south-west by the Nagod-Singpur road in the village Sarwakhaira, 1 km north of Nagod-Panna road, the village Saipur and the village Kathwari, respectively. Survey of this unit brought into light three sites namely Saipur-I, Saipur-II and Saipur-III.

The site, Saipur-I (24°33′40″ N ; 80°50′24″ E) is located about 3 km south of Nagod proper on the right side of Chapa-Nagod road and about 0.5 km west of river Amaran. It is a low relief weathered rock and relatively in the open surroundings. No exposed section is found at the site. The size of the site is about 10 m × 4 m and south-north oriented. The distribution of artifacts is even. All artifacts are either fresh or slightly abraded and have no sign of water rolling and have thin patination. The site can be assigned as inprimary context. Following the simple random sampling procedure the site was divided into 2 m × 2 m sample units. Thus, ten sample units provided and out of these 10% i.e. one random sample unit (sample no. 3) was collected which consisted of 7 artifacts. The artifacts are mainly fashioned on quartzite and only a few cobbles and boulders are available in the adjacent area. On the basis of typology and technology it can be assigned to Middle Palaeolithic period.

The site, Saipur-II (24°32′25″ N ; 83°33′ E) is situated about 100 m south-west of Saipur-I and about 600 m west of Amaran river. It is also on a low relief weathered rock and relatively in open surroundings. No exposed surface is present at the site. The size of the site is about 5 m × 3 m and south-north oriented. The distribution of artifacts is even. Most of the artifacts are patinated, fresh or slightly abraded and have no sign of water rolling. Considering all these factors and topography of the site it can be said that the site belongs to a primary context. Following the simple random sampling procedure the site was divided into 1 m × 1 m sample units. Thus, a total of 15 sample units produced. Out of these sampling units 13%, 2 random sample units—1 and 7, was collected which comprised of 70 and 130 artifacts, respectively. A total of 200 artifacts was collected at the site. Mostly they are made on chalcedony, agate, chert and carnalian. There is an absence of source of raw material close to the site except the river beds. On the basis of typology and technology it can be classified into Mesolithic period.

The site, Saipur-III (24°33′ N ; 80°32′30″ E) is found on the left side of Chapa-Nagod road and about 2 km south of Nagod proper. It is about 1.5 km west of Amaran river and 1 km west-north of Saipur. It is lying over the flat yellowish silt containing consolidated CaCo3 deposit and almost in open surroundings. This deposit rests on the weathered rock. The exposed size of the site is about 10 m×2 m and west-east oriented. The distribution of artifacts is relatively uneven. Most of the artifacts are patinated and bear no sign of water rolling which suggest that the site is most probably in primary context. Following simple random procedure the site was divided into 1 m×1 m squares which produced 20 sampling units. Out of these units a 10% sample (sample no. 14 and 12) was collected. These sample units consisted of 8 and 13 artifacts, respectively. Thus, a total of 21 artifacts was collected. Artifacts are generally made on chert. The river beds would have been the source of raw material. Typologically and technologically it can be placed in the period of late Upper Palaeolithic, as similar type of artifacts have been placed by other scholars in Indian context.

Sample 16 (24°32′20″—24°36′ N ; 80°49′—80°53′ E)

The sampled unit is bound on the north-east, north-west, south-east and south-west by the village Badkarra, Allahabad-Katni Central railway line, the river Tons and railway bridge on the river Satna, respectively. Four sites have been noticed in this sample. These are Sagatha, Belhata-II, Sinaora and Belhata-I.

The site, Sagatha (24°33′40″ N ; 80°51′ E) is located about 5 km south of Satna Aerodrome. It is on a low relief weathered rock and relatively in open surroundings. It is about 4 k m and 4.5 km west of river Tons and north of river Satna, respectively. The exposed section at the site revealed that artifacts are associated with yellowish red deposit which is overrain by 10 cm thick humus layer (Sinha, 1984 : 93). The size of the site is about 24 m×12 m and north-south oriented. The distribution of artifacts is even. Artifacts are mostly fresh and slightly abraded with a thin layer of patination. Topography of the site and physical condition of artifacts suggest that the site probably belongs to primary context. Following the simple random sampling procedure the site was divided into 4 m×4 m sample units which provided 18 units. About 11.1% sample, 2 sample units, 9 and 14, was collected. Sampled units consisted of 9 and 8 artifacts, respectively. Thus, a total of 17 artifacts was collected. The artifacts are fashioned on quartzite. Close to the site only a few cobbles and boulders are present. Typologically and technologically it belongs to Lower Palaeolithic period.

The site, Belhata-II 24°32′30″ N ; 80°52′ E) is situated about 8 km south of Satna proper. It is about 2 km and 4 km west of river Tons and north of river Satna respectively. Artifacts are lying over the high relief weathered rock and relatively in open surroundings. The size of the site is about 30 m × 9 m and north-south oriented. The distribution of artifacts is even and bearing thin patination. Most of the artifacts are fresh and slighty abraded. On the grounds of topography and physical condition of artifacts it can be said that the site is in primary context. Following the simple random sampling procedure the site was divided into 3 m × 3 m quardrate units which produced 30 sampling units. Out of that about 10% was collected. The three sampled units were 1,7 and 14 consisted of 7, 8 and 5 artifacts, respectively. A total of 20 artifacts was collected at the site. The artifacts are fashioned on quartzite. A few cobbles/boulders are present in the adjacent area of the site. Typologically and technologically the site can be placed into the period of Lower Palaeolithic.

The site, Sinaora (24°32′30″ N ; 80°33′20″ E) is found about 4.5 km of Satna proper and about 1 km north-west of the site Sagatna. It is on the high relief weathered rock, relatively in open surroundings and about 3 km and 5 km south of river Satna and west of river Tons, respectively. The size of the site is 7 m × 4 m and south-north oriented. The distribution of artifacts is even and bear a thin coating of patination. Most of the artifacts are fresh and slightly abraded. The physical condition of artifacts and topography of the site suggest that it is in the primary context. Following the simple random sampling procedure the site was divided into 1 m × 1 m units which provided 29 sampling units. About 10.7% of them was collected through three units—9, 4 and 26. No artifact was found in the sampled unit 9 while the other two yielded 7 and 5 artifacts, respectively. Thus, a total of 12 artifacts was collected. Artifacts are made on quartzite. Only a few boulders and cobbles are present in the adjacent area. Typological and technologically this can be placed into the period of middle Palaeolithic.

The site, Belhata I (24°32′31″ N ; 80°52′ E) is located about 8 km south of Satna proper. The site is present on a high relief weathered rock and relatively in open surroundings. It is about 100 m east of Belhata-II and, about 3.5 km and 2 km south of river Satna and west of river Tons, respectively. The size of the site is 6 m × 5 m and east-west oriented. The distribution of artifacts is not even and are patinated. Mostly artifacts are fresh and slightly abraded. It can be placed in a primary context. Following the simple random sampling procedure the site was divided into 1 m × 1 m sampling units which produced 30 units. Out of that about 10% random sample was collected at the site. The random samples were 11, 25 and 26 comprised of 9, 0, and 6 artifacts, respectively. Thus, 15 artifacts were collected. These are fashioned on quartzite. A few cobbles and boulders are present close to the site, Typologically and technologically the site can be classified into Middle Palaeolithic period.

Sample 64 (24°14'–24°17'40" N ; 80°42'–80°42'–80°46' E).

This quardrate is marked on the north-east, north-west south-east and south-west by the nala Lilji and Allahabad-Katni Central railway line, hills, 2.5 km south of Maihar railway station and 1.5 km east of Central railway line and hills, respectively. A total of six sites and one occurence was noticed in this sample. Sites are Sharda Temple I, Sharda Temple II, Sharda Temple III, Sharda Temple IV, Sharda Temple Ia and Rampur I and, occurence is Rampur II.

The site, Sharda Temple I (24°15'30" N ; 80°43' E) is located about 800 m south of Maihar-Sharda Temple road and on the left bank of south branch of Lilji nala. The site is lying over the high relief weathered rock and close to the Lilji nala which is now a dry bed and only during the rainy season water flow in this branch. This weathered rock is gradually sloping towards west and on its west-north side a chain of hills is present. The size of the site is 32 m × 24 m and east-west oriented. The distribution of artifacts is not very even and artifacts are thinly patinated. The artifacts are mostly fresh and slightly abraded suggesting thereby primary context nature of the site. Following the simple random sampling procedure the site was divided into 4 m × 4 m quardrate which produced 48 sampling units. Out of which 5 random sample units, i.e. about 10.4%, were collected. These sampled units were 24, 33, 14, 12 and 28 which consisted of 11, 9, 12, 10 and 10 artifacts, respectively. Thus, a total of 52 artifacts was collected. The artifacts are made on quartzite. The raw material in the form of boulders/cobbles is available close to the site. Typologically and Technologically the site can be placed into the period of Lower Palaeolithic.

The site, Sharda Temple II (24°15'32"N; 80°43' E) is about 500 m south of Maihar-Sharda Temple road. This is also on also on a high relief weathered rock and surrounded by a chain of hills present on the west-north of the site. Luckily, close to the site a 2m × 3m trench was dug by Civil Department which provided a preliminary stratigraphy at the site (Sinha, 1984:104) and suggested that artifacts were associated with reddish yellow silt mixed with shale fragments and capped by a 10 cm deposit of humus layer. Mostly artifacts are fresh and slightly abraded. The distribution of artifacts is even and have a thin patination. The site can be placed into primary context. The size of the site is about 40m × 24m and east-west oriented. A good number of artifacts were lying on the southern slope of the site, therefore, stratified random sampling procedure was followed. The site was divided into two strata-stratum I and stratum II and each into 4m × 4m sampling units which produced 60 sampling units. Out of each stratum an independent 10% sample was collected. The sampled units of stratum I and II were 45, 3, 27, 19, 6 and 3, respectively. These sampled units consisted of 9, 9, 14, 11, 9 and 10 artifacts, respectively. Thus, a total of 62 artifacts was collected at the site. The artifacts are fashioned on quartzite and the raw material in the form boulder sand cobbles is available close to the site. Typologically and Technologically this can be classified as Lower Palaeolithic site.

The site, Sharda Temple III (24°15'34"N; 80°43'1"E) is situated about 70m south of Maihar-Sharda Temple road and about 500m east of the foot of Sharda Temple hill. It is relatively on a low relief weathered rock and a chain of hills is present on its west-north side. Exposed edges of the mound show almost similar stratigraphy as noticed at Sharda Temple II (Sinha, 1984:104-5). The size of the site is 32 × 24m and east-west oriented and distribution of artifacts is even and bear a thin coating of patination. The physical condition of artifacts is generally fresh and slightly abraded. All evidences suggest that the site is in primary context. Because a good number of artifacts were lying on the eastern slope of the site the stratified random sampling procedure was used to collect artifacts. The site was divided into two strata—stratum I and stratum II and each into 4m×4m sampling units. A total of 48 sampling units produced. Thereafter, an independent random numbers for each sampling frame was selected. These units in stratum I and stratum II were 9, 4, 26, 38 and 5, respectively. These sampled units consisted of 10, 13, 11, 11 and 10 artifacts, respectively. Thus, about 10.4% sample comprised of 55 artifacts was collected. The artifacts are made on quartzite. Raw material in the form of boulders and cobbles is available close to the site. Typologically and Technologically the site can be placed into lower Palaeolithic period.

The site, Sharda Temple IV (24°15'36"N; 80°43'2"E) is located about 150 m north of the Maihar-Sharda Temple road. At present this site is on two high relief weathered rocks on the right bank of Lilji nala (northern branch) and surrounded by a chain of hills on its west-north side. These mounds would have been one at the time of its occupation and in due course of time a rain gully divided it into two. Stratigraphy recorded at the site from the exposed edges of the mounds is almost similar to these noticed at Sharda Temple II and at Sharda Temple III (Sinha, 1984:104-5). The size of the site is 27m × 15m)+15 m×3m) and north-south oriented. The distribution of artifacts is not even and artifacts have a thin patination. Mostly artifacts are fresh and mederately abraded. On the basis of topography and physical condition of artifacts this site can be placed in primary context. To collect artifacts stratified random sampling procedure was used and site was divided into three strats—stratum Ia, Ib and II. Stratum II was laid on the eastern and northern slope of stratum Ia and Ib, respectively which gave appearance to Stratum II like the English alphabet 'L'. Thereafter. each stratum was divided into 3m×3m sampling units which provide 50 sampling units. Out of these units an independent random sample was selected from each stratum for 10% sample collection. These sampled units for stratum Ia; Ib and II were 3 and 19 : 6 and 11 : and 3, respectively. These sampled units consisted of 20, 13; 10, 9 and 15 artifacts, respectively. Thus a total of 67 artifacts was collected. The artifacts are made on quartzite and the raw material in the form of boulders and cobbles is present nearer to the site. Typologically and Technologically this site belongs to Lower Palaeolithic period.

The Rampur II (24°17'30"N; 80°42'35"E) is found about 1.5 km north of Sharda Temple. The artifacts are lying over the exposed lower gravel of Lilji Section (Sinha, 1984;130-53) and closely surrounded by a chain of hills on its west-north side. The physical condition of artifacts suggest that mostly artifacts are heavily abraded and bear signature of water rolling. The size of this occurence is about 30m×9m and west-east oriented. The distribution of artifacts is not even. The topography and physical condition of the artifacts suggest that the artifacts are in secondary context. However, to compare this assemblage from other primary context sites a 10% sample was collected. Further, the exposed surface was divibisible into two strata a stratified random sampling procedure was adopted. 30 sampling units were produced by dividing each stratum into 3m×3m units. An independent random sampled units for stratum I and stratum II were 17, 9 and 1, respectively. These sampled units consisted of 10, 6 and 6 artifacts respectively. Thus, a total of 22 artifacts was collected at this occurrence. The artifacts are fashioned on quartzite. Typologically and technologically this can be placed into Lower Palaeolithic period.

The site, Rampur I (24°17'N; 80°42'40"E) is situated about 1 km north of Sharda Temple. It is a high relief weathered rock and surrounded by a chain of hills on its west-north side. Lilji nala is about 300m north of this site. The size of the site is about 16m×10m and west-east oriented. The physical condition of artifacts is fresh and slightly abraded. The distribution of artifacts is not even. On the ground of physical condition of artifacts and topography this can be classified as a primary context site. Following the simple random sampling procedure the site was divided into 2m×2m sampling units which produced 40 sampling units. Out of which about 10% sample was collected through four random samples—24, 33, 14 and 12. There was no artifact in sampled unit 33, while the rest consisted of 3, 6 and 5 artifacts, respectively. Thus, a total of 14 artifacts was collected. Artifacts are made on quartzite. A few cobbles and boulders are present close to the site. Typologically and technologically this site can be placed into the period Middle Palaeolithic.

The site, Sharda Temple Ia and the site Sharda Temple I are on one and the same place. But the size of Sharda Temple Ia is only about 6 m×5 m and east-west oriented. The distribution of artifacts is not even. Mostly artifacts are fresh and heavily patinated and, fashioned on chalcedony, agate, chert and carnalian. Topography and physical condition of artifacts suggest primary context nature to the site. Following the simple random sampling procedure the site was divided into 1 m×1 m sampling units which provided 30 units. Out of that about 10% sample was collected through sampled units—9, 4 and 26. These units consisted of 70, 250 and 131 artifacts, respectively. A total of 451 artifacts was collected. The source of raw material would have been probably the river beds. Typologically and technologically the site can be classified as Mesolithic site.

Sample 18 (24°32′20″—24°36′ N ; 80°57′—81°1′ E)

This quardrate is marked on north-east, north-west, south-east and south-west by Nat nala in the village Hinouti, the village Jamaon, the village Nimua and the village Tikura, respectively.

Only one occurrence was found in this sample. It is situated about 5.5 km north of Satna-Rewa road and 2 km west of Nat nala. It has been named as Hinouti. Because of secondary context nature and as only a few artifacts fashioned on quartzite were present on the exposed lower deposit of Hinouti section (Sinha, 1984 : 79-80) no sampling was done. Artifacts are moderately rolled and can be placed on the basis of typo-technology into the period of Lower Palaeolithic.

Site Analysis

The principal theme of this section centres around the identification of probable relationship between the sites and region particularly in terms of topographical features and potentiality of sites in the region.

The sampled units of the region covering an area of about 491.5 km^2 brought to light the existence of about 18 sites and 3 occurrences. On the basis of typo-technological consideration of the associated artifacts these 18 sites may be classified with considerable degree of confidence into four periods i.e. Lower Palaeolithic, Middle Palaeolithic, Upper Palaeolithic and Mesolithic. Their frequencies read 8, 4, 2 and 4 respectively (Table 1). The three occurrences designated as Rampur II, Kasala Hill and Hinouti appear to be of Lower Palaeolithic period. These occurrences have not been included in the data for further analysis due to low level of confidence of their identity.

Table 1

Inventory of Stone Age sites in Sampled Population : Study Area, Satna District (Madhya Pradesh

Cultural Period	*Sampled Units*												*Total*
	3	*6*	*11*	*14*	*16*	*18*	*19*	*27*	*45*	*57*	*59*	*64*	*Sites*
Lower Palaeolithic	—	—	—	—	2	—	—	2	—	—	—	4	8
Middle Palaeolithic	—	—	1	—	2	—	—	—	—	—	—	1	4
Upper Palaeolithic	—	—	1	—	—	—	1	—	—	—	—	—	2
Mesolithic	—	—	1	—	—	—	2	—	—	—	—	1	4
Total	—	—	3	—	4	—	3	2	—	—	—	6	18

(i) TOPOGRAPHICAL RELATIONSHIP

Lower Palaeolithic sites—All sites are located on the weathered rocks, though on the basis of morphometric features of weathered rocks it can be said that five are on high relief weathered rocks and the rest on the low relief weathered rocks. The nearest water source in four sites is nala and about on average 300 m, while in the rest four sites it is river and varies from 3 km to 5 km. Five sites are relatively closer to the raw material source.

Middle Palaeolithic sites—These four sites are on weathered rocks. On the basis of morphometric features of weathered rocks, three sites are on high relief and one on the low relief weathered rocks. The source of raw material is not close to these sites and only a few boulders and cobbles are available in the adjacent area. For two sites water source, nala as well as river, is about at 0·5 km distance, and in the case of the rest two sites it is river and about 3 km to 5 km.

Late Upper Palaeolithic sites—Both sites are on the flat exposed Satari formation (Sinha, 1984 : 130-53). The raw material is not present in the adjacent area, except in the river beds. These sites are about 0.5 km and 1.5 km from the water source which is in both the case river.

Mesolithic Sites—Two sites are on flat mounds and the rest two are on weathered rocks (low/high relief). Three sites are close to nalas and one close to river. Two sites are about 20 m from the nala and the rest two are about 300 m and 600 m from the nala and river respectively. The nearest source of raw material is river bed.

(ii) POTENTIALITY OF SITES

On the basis of known parameters scholars like Chenhal (1975), Judge, et. al. (1975) have also made attempt to compute the reliability of sample procedure by comparing observed and expected frequencies through *Chisquare* test. It has been observed that all type of probability sampling procedures and designs such as random quardrat, random transect, systematic quardrat, interval (systematic) transect, etc., provide almost similar results for the estimation of total number of sites in the given regions. Moreover, it is found that simple random procedure vary in frequency estimation for the cultural period. To test the reliability of sample procedures used in the survey of district Satna an attempt was made by the present author and it is found that probability sampling procedure provide results close to the informations gathered after surveying the whole region. This procedure also retrive more or less similar ratio of different cultural periods as well as reliable computed expected parameter range of sites and/or sites of different cultural periods one would get after surveying the whole region (Sinha, n.d.).

The standard deviation of the sampled units for site frequency is 2.06 with the mean of 1.5. If we make a tentative estimation for total number of sites in the sampled population using the above sample mean the area sampled in question may be expected to provide about 118 sites. However, in view of the standard error of the sample for the variable site reading 0.53 the parameter mean range would be about 1.5± (1.96×0.53) i.e. 1.5±1.03 or between 2.5 and 0.48. Therefore, the frequency of sites in the sample population is expected to range from 38 to 197.

CONCLUSION

The use of probability sampling procedure proved highly rewarding. The said procedure is the most economical and precise scientific tool to know about the inventory of Stone Age sites or archaeological sites in the region. It is revealed from the fact that by surveying only about 491·5 km^2 out of about 3145 km^2 of sampled/target population, we found evidences about the presence of prehistoric man in the study area right from the Lower Palaeolithic period to Mesolithic period. Through this procedure we are able to infer about the parameter range of sites in the sampled population which ranges from 38 to 197 sites. This procedure also reduces human biases in the course of collecting artifacts at the site as well as most of those biases that influence in the formation of sites (Sinha, 1984 : 372-76).

A question may be raised by a few scholars that if a survey is done in a small portion of a district in detail instead of surveying 'here and there' (i.e. following the probability sampling procedure), it would represent the inventory of archaeological sites of the district. The author's answer to such questions is that the boundaries of a district are generally not natural boundaries rather administrative boundaries. So, if one surveys a small portion at the meeting place of 3 or 4 districts, could he claim that his data represent the inventory of archaeological sites of all the 3 or 4 districts. While adopting the probability sampling procedure, we can say that our data are representative of sampled population and to some extent of Satna district because of strategy and operational planning adopted in this research.

This procedure also provides data to study the settlement pattern of prehistoric inhabitants in whole of the region (sampled population) and not only in and around the river valleys (cf. Paddayya, 1978).

To sum up it can be said that the probability sampling procedures should be adopted in archaeological field work and in the laboratory.

FOOT-NOTES

1. After excluding the portions of sample units—30, 51, 61, 62, 71 and 72 which are out side the district Satna.
2. It is quite easy to divide an area into units on map, but difficult indeed to make the demarcation in the field. However, in this work railway tracks, roads (melted and mud), river, nala, hills and villages have been used to distinguish various units as marked on the map (Fig. 1). They were marked in detail on the blue print of the survey map using 1"—1 mile and 1"—4 miles survey sheets of the region.

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A Preliminary Note on the Quaternary Deposits of the Upper Sarju Basin in Kumaon Himalaya

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ABSTRACT

The upper Sarju, a glacier fed river originates from north of Jhuni and flows south-southwest, draining the Central Kumaon Himalaya. The extreme northern part of the basin shows trellis to annular drainage, however, the general pattern is dendritic.

The most common Quaternary sediments constitute the three well developed terraces and various cliff sections. In the upper reaches some morainic deposits are observed. It seems that there were two glacial and three inter-glacial sequences in the valley. The three inter-glacial periods are characterised by the formation of three high level terraces. The first glaciation is marked by the moraines found above 2000 metres and the second at lower altitudes which enters directly into the stratigraphic sequences at places.

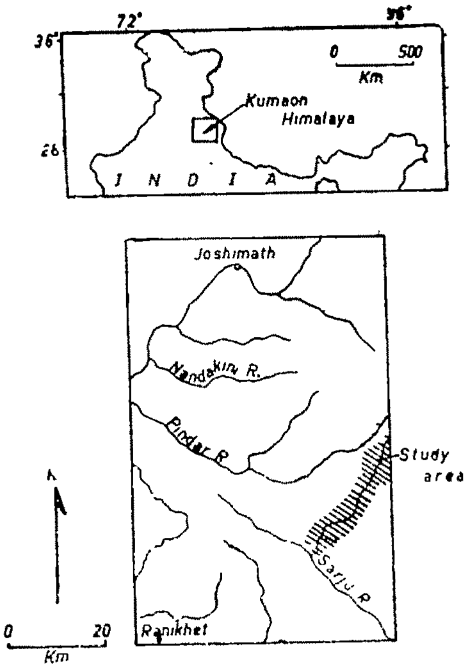
INTRODUCTION.

Quaternary deposits of Kumaon have as yet not received the attention they deserve by virtue of their geomorphological diversity and varied depositional environment. The present author has therefore investigated the upper Sarju basin (Fig. 1) in Kumaon because various evidences preserved in the valley are very vital for a proper understanding of Quaternary deposits. A variety of landforms constitute the basin resulting from an unique combination of glacial, fluvio-glacial and fluvial processes operated essentially within the Quaternary period.

Middlemiss (1890) carried out some work on the physical geology of Garhwal and Kumaon. Except some cursory references by Heim and Gansser (1939), Gansser (1964), Valdiya (1984) on the terrace formations and other geomorphic features, no systematic morphologic analysis is available in the literature on Kumaon Himalaya. The present preliminary first hand studythrows some light on the various Quaternary deposits and geomorphic features of the upper Sarju valley in Kumaon.

The upper Sarju basin is rich for its water resources, being drained by glacial fed river Sarju, which originates near the junction of two Kautela (3,935 M) and Pankhuwa (4,144 M) ridges. The river flows south-south west and drains the Central Kumaon Himalaya. The extreme northern part of the basin shows annular drainage, however the general pattern is dendritic, characterised by irregular branching of tributary streams at almost right angles. At many places in the northern part the river is joined by the first order streams, mostly flowing along the strike of the rock formations and thus giving rise to a trellis type of drainage reflecting marked tectonic control. The dendritic type of drainage is more common in metasedimentaries which indicate uniform

Fig. 1



LOCATION MAP OF THE STUDY AREA

TABLE 1

LITHOSTRATIGRAPHY OF TERRACED QUATERNARY SEDIMENTS OF UPPER SARJU

Formations	*Lithological characters*
Terrace T_1	Stream channel, flood plain deposits, colluvial material, pebbles and gravel beds, mixed rock fragments alongwith fine matrix (20 M).
Terrace T_2	Gravel and boulder beds with sandy and clayey horizons, subrounded to rounded rock fragments of quartzite, gneisses dolomitic limestones, slates, etc. with alternating gravel and sandy layers (10 M).
Terrace T_3	Wellrounded unstratified boulders of quartzite and dolomitic limestones with a mixture of metamorphic rocks along with fine sand (5 M).

resistance of rock formations to erosion. In the northern part, the dendritic pattern is locally developed.

QUATERNARY DEPOSITS

The Quaternary sediments constitute the three well developed terraces and various cliff sections along the river. The terraced deposits are generally semi consolidated but occasionally fine stratifications are observed by the author. The detailed lithostratigraphy of the Quaternary sediments of Upper Sarju valley are summarised in the Table 1.

The Sarju valley which is bounded by the Great Himalaya (snowfed) in the north is a tectonic valley. The valley has been modified by the alluvium, mostly composed of sandy silt and clayey material. The most impressive morphological feature of the area is the series of high river terraces. Three distinct terraces have been observed at several places on its course. The highest T_3 is at about 120 m above the water level while T_2 and T_1 are respectively at 30 m and 10 m (average). The T_3 is developed at places only and comprise 75% unstratified boulders of quartzite, dolomitic limestones, metamorphic rocks, slates etc., and 25% fine sand. The T_2 terraces are about 10 m in height and comprise 35%, gneissic rocks, 15% quartzites, 10% dolomitic limestones slates and phyllites, 30% sandy, silty and clayey material and 10% gravelly material. T_2 contains large quantity of metamorphic rocks as compared to T_3 and T_1. The average height of T_1 terraces is 10 m and is composed mainly of materials derived from the T_2 and T_3. At places it is seen to comprise 30% colluvial material, 20% pebbles and gravels, 20% mixed rock fragments and 30% fine matrix. The terrace deposits near Dulan show the charateristics of fan deposits, which could have been formed due to action of heavy rains and snow on the steep slopes of the hills.

All along Sarju fluvio-glacial deposits, screes, landslide debris and fan or cone deposits are noticed. The cliff section at Dulam and Munar show a well-

CLIFF SECTION AT DULAM AND HATSILA

Dulam		*Hatsila*	
Lithology	*Thickness*	*Lithology*	*Thickness*
5. Recent scree deposits	—	—	—
4. Non calcareous reddish silt	12 m	4. Limestone scree deposit.	—
3. Brownish sandy silt showing cross laminations.	5 m	3. Greenish, brownish sand.	20 m
2. Well sorted bouldery gravel with laminated silty clay.	4 m	2. Well sorted, compact, crudely stratified conglomerate, intercalated with crossbedded sands.	10 m
1. Basal subangular to subrounded boulders of varieties of metamorphic rocks, quartzites, volcanics, slates, phyllites and limestones, well cemented boulders with calcareous material are also not uncommon	10 m	1. Greenish sandy silt.	6 m

developed Quaternary succession. The basal boulders ranging in size between 4 to 6 m and 4 to 8 cm across form the basement, life unconformably over the Deoban's. The majority of the boulders are subangular to subrounded and are well cemented with calcareous material. The lithological components are varieties of metamorphic rocks, quartzites, slates, phyllites and volcanics showing laminated clays and well sorted boulders. This in turn is overlain by non calcareous reddish slit. It is a waterlaid deposit measuring nearly 12 m and topped by recent scree material (Fig. 2 a). A massive alluvial cone developed on the right bank of the river can be seen south of Munar, which has subsequently been cut into a terrace.

A fine cliff section near Hatsila shows from bottom upwards greenish sand of about 6 m thickness resting directly on the Deoban limestone and overlain by 10 m boulder conglomerate (Fig. 2 b). It is fairly well sorted and compact but crudely stratified and at places it is intercalated with cross bedded sands. The pebbles range in size from 1.5 cm to as large as 20 cm across and they are subrounded to rounded. Over this boulder conglomerate lie layers of sands of about 20 cm thickness. They are covered by the limestone scree deposits.

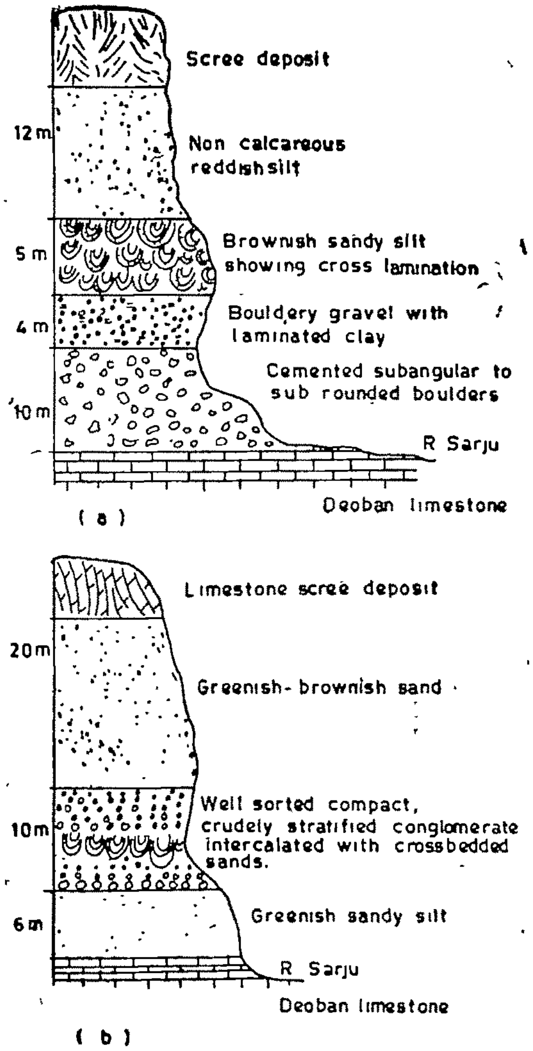

Scree deposit
12 m
Non calcareous reddish silt
5 m
Brownish sandy silt showing cross lamination
4 m
Bouldery gravel with laminated clay
10 m
Cemented subangular to sub rounded boulders
R Sarju
Deoban limestone
(a)
Limestone scree deposit
20 m
Greenish- brownish sand
10 m
Well sorted compact, crudely stratified conglomerate intercalated with crossbedded sands.
6 m
Greenish sandy silt
R Sarju
Deoban limestone
(b)

Fig. 2 LITHOSTRATIGRAPHIC PROFILS
(a. Dulam, b. Hatsila)

DISCUSSION

A few morainic deposits were noticed in the upper part of the valley above 2000 meters and solifluction material was noticed all along the hill slopes. The morainic deposits in the upper reaches of the valley give some idea of the deposits of T3 terrace, that could be attributed to the glaciers. The presence of gneissic and quartzite boulders at a height over 100 m might have been brought by the floating ice. In the upper most part of the basin, the components of the loosely cemented bouldery gravel containing gneissic and quartzitic rocks in the T2 terrace deposits are mostly angular and at places fairly rolled particularly at lower level. It seems that there were two glacial and three interglacial sequences in the upper Sarju valley. In the first interglacial period the T3 terrace was formed followed by the first glacial period characterized by moraines in the northern part of the basin. The second interglacial period gave birth to the T2 terraces followed by the second glaciation which extended far south at lower altitudes, enters directly into the stratigraphie sequences at Dulam and near Hatsila. Heterogenity in texture, poor sorting and the massive nature of the formations indicate the glacial origin. The rounding of the components in the lower reaches of the basin shows dominance of fluvial action. It is possible that such boulder pebbles might have been derived from the erosion of the pre-glacial geological formations in the upper reaches and their discharge and final deposition towards south must have been affected through glacial agency. The glacial evidence of latter phases are not well preserved in the valley.

The glacial moraine has been found only above 2000 meters, thus it can be concluded that during the Pleistocene the maximum glacial extent was upto the spot which is at present at a height of 2000 metres. The fresh water gastropod shells have been observed in the third high level terraces at places, which suggests a Late Pleistocene age. The impact of monsoon due to high relief may be intense and has developed huge alluvial fans, scree apron slopes and cones. In the tectonically disturbed areas the terraces are found at high altitude, which throws light on the neo-tectonic activity in the area. A possible account of the two glacial and three interglacial periods can be shown as following :

III	Interglacial	Terrace T_1	Upper Pleistocene
II	Glaciation	Conglomeratic beds at lower levels	Riss ?
II	Interglacial	Terrace T_2	Middle Pleistocene
I	Glaciation	Morainic deposits above 2000 metres	Wurm ?
I	Interglacial	Terrace T_3	Lower Pleistocene

ACKNOWLEDGEMENT

The author is grateful towards Prof. S.S. Merh for his kind help.

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The Prehistory of Sri Lanka : An Outline*

S. U. Deraniyagala

ENVIRONMENT

Sri Lanka is an island some 40 km off the southern tip of India, at ca. 80° east long. by 8° north lat. The form is ovate, with a maximum length and breadth of ca. 400 and 220 km respectively. Physiographically, the island is composed of three peneplains separated by escarpments. These peneplains are at ca. 0.30m, 420-750m and 1,600-2400m, above sea level, with the highest forming a central massif. The climate is equatorial, with average annual temperatures ranging between ca. 12°C in the mountains and ca. 33°C in the coastal plains, and there is very little seasonal fluctuation. The pattern of rainfall is dominated by the Southwest Monsoon during the summer, supplemented by tropical cyclonic and convectional rains during the remaining months. The country can be divided into two major ecozones, the Wet Zone in the west and southwest and the Dry Zone encompassing the balance two-thirds of the island. The Wet Zone in itself is divisible into lowlands, uplands and highlands, and the Dry Zone into arid, semi-arid and dry lowlands, dry uplands and the intermediate-dry lowlands. It is important to bear in mind that the central mountains act as a rain trap for the summer Southwest Monsoon, which then traverses the Dry Zone as a dry katabatic wind. Winter witnesses cyclonic rain storms affecting the summer-dry Dry Zone. The Wet Zone averages around 2500 mm of rain per annum, whereas the Dry Zone varies between 950 and 1,900mm.

CHRONOLOGY

Sri Lankan prehistory has a fairly extensive literature. The initial probes took place around 1880, and a relatively sustained course of enquiry has been maintained ever since, latterly almost entirely under the auspices of the Department of Archaeology of the Government of Sri Lanka.

Potentially, the oldest Quaternary deposits in Sri Lanka comprise the Ratnapura Beds. These are alluvial sediments filling the strike valleys in the lowlands of the south-western Wet Zone. They consist of sands, silts and clays ranging up to 30m or more in depth, with gravel intercalations in the basal levels. These gravels have occasionally yielded artefacts of a chopper industry, termed the Ratnapura Industry, made of quartz and chert. The gravels also contain a fossil fauna, the Ratnapura Fauna, which includes palaeoloxodont elephants, two rhinoceri, and the hippopotamus *Hexaprotodon palaeindicus*. The last occurs in the second major aggradation cycle of the Pleistocene alluvia in peninsular India, which, by correlation with coastal tracts in south-east India and hence by eustatic altimetry, I have tentatively dated to the last interglacial period at ca. 125,000-80,000 BP. A discovery of some significance is that of a probable hominoid incisor tooth, which has been compared to *Gigantopithecus*, and of a hominid premolar, in separate localities of the Ratnapura Beds. Then there are bovine fossils, smaller than anything assignable to a water buffalo or gaur, which could be ancestral to modern *Bos indicus*.

However, despite the indubitably Pleistocene element in the Ratnapura Beds, the chrono-stratigraphy of these sediments is still far from clear. Certain artefactual

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*Reprinted from *Festschrift 1985-James Ruatnam*, A.R.B. Amerasinghe and S.J. Sumanasekera Banda ed., Sri Lanka : UNESCO, (1985).

contents, faunal elements and uranium assays have indicated that some of the beds have undergone redeposition thereby complicating the stratigraphy. A detailed survey, employing careful coring, will be required before further stratigraphic resolution can be achieved.

Moving on to another set of Quaternary sediments, the coastal tracts of the semi-arid zone, particularly in the northern sector, are characterised by large expanses of sheet gravels capped by sands which have undergone latosolic weathering resulting in a colour range of buff to crimson. These two beds in combination are referred to as the Iranamadu Formation. The sands have conclusively been identified as being ancient coastal dune sands weathered into aeoleanites. The basal gravels are coastal alluvial in facies, and thus hypothetically amenable to eustatic altimetric studies.

In 1972, the present writer set out to ascertain the antiquity of two separate sets of deposits of the Iranamadu Formation at Bundala in southern Sri Lanka. In the first instance, the basal gravel was at ca. 8m above present sea level, capped by ca. 4m of ancient dune sands. The excavations yielded stone age occupation horizons within the gravels and in the overlying sands. The artefacts in the gravels were typologically indeterminate, due to alluvial attrition of diagnostic traits. However, the implements in the sands were clearly microlithic, with a strong element of geometric forms such as lunates and triangles. Unfortunately, no organic remains had been preserved, and hence it was not possible to radiocarbon date these deposits. Recently, however, it has become possible to date dune sands by their thermoluminescence, and Dr. Ashok Singhvi's and Mr. D. Sengupta's (Physical Research Laboratory, India) assays on the samples from the excavation site have dated them to ca. 28,000 TL BP. This dating tallied exceedingly well with Dr. Rita Gardner's (Geography Department, Oxford University) radiocarbon dating of ca. 25,500 BP for the 8m beach in southern India. The only problem was to reconcile the occurrence of geometric microliths with such an early date, particularly since Gardner's sediments in India are not reported to have contained artefacts.

The resolution of this problem as to the antiquity of geometric microliths in Sri Lanka came from two independent sources. Excavations in Kitulgala Belilena cave yielded a consistent series of radiocarbon dates ranging from ca. 12,500 to 10,500 B P.* These levels contained numerous specimens of geometric microliths, as did the earlier layers which are currently being assayed. Hence Kitulgala indicated that geometric microliths are definitely older than 12,500 years in Sri Lanka. This was firmly corroborated subsequently by the results of the excavations in Batadomba cave at Kuruwita. Once again, excellent and numerous specimens of geometric microliths—lunates, triangles and trapezoidals—were excavated from well defined stratigraphic contexts which have provided a very consistent series of radiocarbon dates on charcoal. This latter ranges from ca. 28,500 BP to 11,500 BP**, thus leaving no doubt whatsoever that the dates from Kitulgala and Bundala are reliable. One simply has to accept the fact that geometric microlithic industries, technologically what one would term Mesolithic, are very much earlier in Sri Lanka than hitherto estimated : supporting evidence has recently been forthcoming from van Noten's work in Zaire (Belgian Congo) and apparently also from Zambia, where geometric microlithic industries have been dated to 28,000 BP and beyond on radiocarbon dating of charcoal. It thus appears that the whole concept of microlithisation, as a prehistoric technological innovation, will have to be raised. Up to now theoreticians have tended to view it in the light of European data, where microliths do not establish themselves as a clearly defined component in the tool assemblages until ca. 12,000 BP. This angle of approach is no longer tenable and the Sri Lankan and African data will have to take precedence.

The second site in the Iranamadu Formation to have been excavated, also at Bundala in the south, relates to a basal gravel at ca. 15 m above present sea level and thus much older than the 8 m level dated to ca. 28,000 TL BP. The thermoluminescence assays on these sediments by Dr. Singhvi have dated them to ca. 74,000 BP, namely the end of the last interglacial (Eem.), The artefact assemblage included backed non-geometric microliths on flakes. There are yet other localities in the Iranamadu Formation where the basal gravels are as much as ca. 60 m above present sea level. These deposits could indeed date back to the Holstein interglacial—having made due allowance for regional tectonic uplift as estimated on available evidence (1 m per 3,500 years)—which would place them back around 2,50,000 BP. Thermoluminescence dating of these sediments is an urgent necessity, even if artefacts do not occur within them. Quaternary stratigraphy in South Asia could thereby witness a major advance with regard to its chronology.

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*Courtesy, Dr Vishnu—Mittre, BSIP.

**Courtesy, Professor D.P. Agrawal, PRL.

The Mesolithic in Sri Lanka has three more absolute dates : ca. 9,700 BP for Alu-lena Attanagoda (C-14),* ca. 7,400 BP for Beli-lena Maniyangama cave (C-14),* and ca. 6,500 BP for the open-air midden at Bellan-bandi Palassa (TL)£. It is difficult to ascertain the exact age of the end of the prehistoric (i.e. Stone Age) period in Sri Lanka in the absence of suitably (radiocarbon) dated deposits. However, the ancient chronicles maintained by the Buddhist monks, and which have provided a very accurate chronology for the historic period of the island from about 250 BC onwards, suggest a terminal date of ca. 500 BC. According to these chronicles, a major episode of settlement by peoples speaking an Aryan language, the present Sinhalese, occurred at about this time. However, there is an intermediate phase between prehistoric to historic, termed the proto-historic period in Sri Lanka, which is characterised by an iron-using technology, agriculture, the horse, a distinctive ceramic termed Black and Red Ware and certain other traits as revealed in the lower levels of the citadel of Anuradhapura. It is not as yet possible to date this phase with any certainty ; but there are strands of evidence suggestive of an inception to this phase at ca. 1,000 BC. The historic period proper, with the introduction of writing is thought to have occurred at ca. 250 BC. This is the classic dating based on the Indian Emperor Asoka's chronology. However, once again, hard archaeological data are likely to reveal that writing commenced at a somewhat earlier date than hitherto estimated.

PALAEO-ENVIRONMENT

One of the major topics considered by the current research programme pertaining to Sri Lanka's prehistory is the evaluation of environmental, namely climatic and biotic, fluctuations during the Quaternary. Some of the salient results of this line of enquiry may be set out as follows.

The ancient coastal dunes and underlying alluvial gravels constituting the Iranamadu Formation, which I have referred to earlier, have been investigated for their pedology and geomorphology. There is a large body of evidence to indicate that these sediments were deposited during interglacial or interstadial periods (i.e., altithermals) under a climate of seasonal rainfall of considerable intensity associated with a longer period of summer drought and a rate of evaporation that was higher than that prevailing in Sri Lanka's Dry Zone today.

Pedological studies by Dr. K. De Alwis of the Soil Survey (Irrigation Dept.) have indicated that subsequent to their deposition the sands have not been weathered by climates that were significantly wetter on a non-seasonal, continuous basis, than that prevalent in the Dry Zone today. There are also indications which suggest that Southwest Monsoonal and tropical cyclonic wind velocities during certain altithermals exceeded those of the present. It was the katabatic foehn effect of the Southwest Monsoonal air-stream, with its increased activity during altithermals, that probably produced the marked climatic seasonality apparent in the geomorphology of the sediments. The texture of the basal gravels is suggestive of catastrophic sheet floods, from cyclonic activity, eroding an otherwise desiccated landscape. These data shed important light on the vexed question as to whether tropical atmospheric circulation increased or decreased during the Quaternary glacial/altithermal oscillations as recorded in higher (i.e., temperate) latitudes. For the first time it is possible to gauge the effect of glacial episodes on the Monsoon, which in turn can be extrapolated to the extensive tropical land masses affected by the Monsoonal system. However, one must not underestimate that monster, the Southwest Monsoon: meteorologists consider it to be the most complex weather phenomenon in the world. There is the tropospheric jet-stream oscillating over the Himalayas, intimately associated with the dynamics of the Monsoon which consequently links the Monsoon

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*Courtesy, Dr. Vishnu—Mittre, BSIP.
£Courtesy, Dr. A.G. Wiatte and K.P. Oakley, Oxford.

with weather phenomena at a global scale : recent studies of upper air circulation should provide further insights into Pleistocene S.W. Monsoonal configurations.

In the absence of pollen studies on deposits dateable to the Upper Pleistocene or early Holocene in Sri Lanka, it is not possible to delineate with any precision the climatic sequence associated with this period. However, certain isolated bits of evidence could suggest that the climate since the last Wurm periglacial at ca. 15,000 BP was not significantly different from that prevailing today on the island—certainly as far as the Wet Zone is concerned. In the Dry Zone, namely in the dry lowlands, the presence of certain exclusively Dry Zone vertebrates at Bellan-bandi Palassa—sloth bear, spotted deer, star tortoise—indicates that the climate at 6,500 TL BP was within the range of variation of today's lowland Dry Zone. As for the Wet Zone, more precisely the lowland Wet Zone, the occurrence of the tree snail *Acavus roseolabiatus* at Kitulgala cave from ca. 12,500 to 10.500 C-14 BP also indicates that the climate was very similar to that of today during this period. *Acavus roseolabiatus* has a very restricted range of distribution, some 200 square kilometres, around Kitulgala, depending on a very local combination of temperature and rainfall. The evidence from the molluscan fauna at Kitulgala is corroborated by the discovery of fragments of the wild breadfruit *Artocarputs nobilis** within the same stratigraphic horizons as *A. roseolabiatus.* Indeed, the wild breadfruit—which once again has a restricted habit—the Wet Zone's lowlands and a part of the uplands—occurs in the levels preceding 12,500 C-14 BP which are currently being dated. Finally there is the evidence from Batadomba cave where the genus *Acavus* occurs from 16,000 C-14 BP onwards. These data suffice to indicate that the climate in Lanka's Wet Zone lowlands during the height of the Wurm upper pleniglacial when it was coldest in higher latitudes, was not significantly different from that of today and that the temperature could not have averaged more than 5°C lower than it is today.

TECHNOLOGY

Now comes the question as to how humans adapted to the environmental conditions postulated above, in terms of his technology—which may be considered a totally cultural (defined as learned behaviour) response. The Ratnapura Industry is indefinable typologically, as mentioned earlier. The best one can do is to call it a predominantly chopper industry. Besides, its chronology is far from secure. The only definable prehistoric technological entities, as far as Sri Lanka is concerned, are the microlithic industries. The non-geometric assemblage at Bundala—Patirajawela has been dated to ca. 74,000 BP on the basis of the thermoluminescence assays on correlative sediments ; and geometric microlithic assemblages with microlithic lunates, triangles and trapezoidals at Bundala and Batadomba cave have been dated to ca. 28,000 C-14 and TL BP respectively. The geometric microlithic techno-tradition appears to have survived up to the advent of the proto-historic Iron Age at ca. 1000—500 BC. (A microlith is here defined as a small (<4.5 cm, usually <2 cm) flake or blade with blunting retouch used to achieve a specific planform). Within these microlithic assemblages there are several variants of non-geometric microliths ; and a very conspicuous non-microlithic type is the socalled Balangoda Point which resembles an Australian Pirri Point, except that it is frequently bifacial. Balangoda Points are small (less than 3 cm), exquisitely trimmed points, with shallow trimming designed to control plan-form and cross-section, presumably for aerodynamics and balance in flight; and they have been dated to ca. 20,000 C-14 BP at Batadomba cave and ca. 28,000 TL BP at Bundala.

Apart from the small tool component, the Mesolithic assemblages include relatively crude choppers, some of which are indistinguishable from choppers of the Ratnapura Industry, and hammer-stones, grinders, grindstones, pestles and mortars on gneissic crystalline rocks and, more rarely, on quartz. Of particular note are hammer-stones with one or more dimple pits drilled into them. It is probable that these formed a part of the fire-drill equipment used by prehistoric man. Then there are flat slabs of rock, frequently used as grindstones (probably multi-function artefacts) with numerous dimple pits on the flat surfaces. These are found exclusively in the areas where the wild edible nut, *Canarium zeylanicum,* locally known as *kekuna,* occurs. Hence, it may be proposed they were used for cracking nuts, much as the Australian aborigines use similar stones for cracking their Macademia nuts.

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*Identified by M.D. Kajale, Deccan College.

Apart from the restriction of the above mentioned nut-stones to certain areas in the Wet Zone and the rarity of pitted hammer-stones in the Dry Zone (vs. the Wet Zone), no regional differences in the distribution of stone tool types is discernible. Finally, while non-geometric microliths occur at ca. 74,000 TL BP with geometric microliths appearing at ca. 28,000 C-14 BP, there is no visible evolution of tool types through the last 28,000 years of the island's prehistoric record, although statistical treatment of assemblages in the future might reveal significant quantitative trends through time.

It is perhaps not out of place to highlight the fact that no artefacts assignable to the Acheulean tradition of biface manufacture, namely handaxes and cleavers, have so far been discovered in Sri Lanka. There have indeed been a few false alarms, but on closer scrutiny these have turned out to bear mere spurious resemblances to handaxes. One is at a loss to account for this absence in Sri Lanka of a major technological tradition in the Palaeolithic of the Old World. On the other hand, it is noteworthy that the Acheulian tradition is absent in the extreme south of India, south of the river Kaveri, where, unlike in the Madras region with its abundant supplies of quartzite deposit are lacking. The Acheulian tradition is also absent in the southwest of India, in Kerala State, which is heavily forested and hence parallels the African situation where Acheulian artefacts are notably rare or absent in the non-savanna, heavy-forest regions. These two instances in southern India could give us a clue as to why Sri Lanka does not have Acheulian artefacts : it is probably attributable to the lack of quartzite deposits on the island. as well as the occurrence of heavy rain-forest vegatation which is likely to have prevailed throughout the Quaternary according to present estimates of Pleistocene climatic variability, Both these factors are likely to have acted in combination to serve as a check against the diffusion of the Acheulian tradition in Sri Lanka.

Apart from stone tools, there are the bone and antler artefacts. These have so far been found only in Mesolithic contexts, usually, from cave habitations. The most common category are small single or rhomboidal points. on slivers of bone or antler, that had been ground down. Then there are spatulae ranging in size from small to large, and picks. Serrated, and at times grooved, spatulate objects from Kitulgala constitute a distinctive class, as do the bone slivers with transverse grooving from Ravanalla and Nilgala caves. Barrel beads on bone and disc beads on shell with radial incisions have been found in the caves of Kitulgala and Batadomba (ca. 12,500, 16,000 BP) respectively. Shells of the tree snail *Acavus* with perforations through the body-whorl are likely to have been used as ornaments. Although no harpoons have been discovered, the unaltered spine of a marine ray found at Batadomba (ca. 20,000 – 16,000 BP) resembles one, with its double row of barbs. Awls seem to have been fashioned from longitudinally split teeth of monkeys, and it is possible that the spurs on the shanks of jungle fowl and jaws of pythons were used for similar purposes.

SUBSISTENCE AND SETTLEMENT

Since the stone tools found in the Ratnapura Beds cannot be assigned to primary contexts, it is impossible to so much as speculate as to whether, animals such as the hippopotamus and rhinoceros of the Ratnapura Fauna had been exploited for food by prehistoric man, although the chances are that they were indeed. As for the settlements in the ancient coastal dunes, the Iranamadu Formation, the permeability of these sediments and tropical climatic conditions have led to the destruction of any organic remains there might have been within them. Hence it is not possible to point to any substantive data on prehistoric subsistence practices pertaining to these deposits. However, being a coastal environment, it is very likely that the rather considerable marine resources occurring in the lagoons of the semiarid zone of Sri Lanka would have been exploited by prehistoric man living on the sand dunes. Recent excavations at Mantai have exposed a Mesolithic habitation, at the upper limit of the then intertidal zone, with remains of dugong, conch shell and other shellfish which had been consumed. About 35km to the north of Mantai there is a series of Stone Age oyster middens along the Mandakal-aru river near the estuary.

It is the sites in the hinterland, particularly caves in the lowland Dry and Wet Zones, that have provided the bulk of the data pertaining to prehistoric (i.e., Mesolithic) subsistence practices. Among the animals exploited for food were : elephant (young), gaur, water buffalo, sloth bear, pig, sambhur, spotted deer, muntjak, chevrotain, porcupine, hare, giant squirrel, flying squirrel, pangolin, civet cat, monkey, jungle fowl, spur fowl, python, land monitor lizard, hard and soft-shelled terrapins, star tortoise, mahsier and small fish (*Puntius titteya*), freshwater crabs and molluscs, and terrestrial and arboreal molluscs, notably of the genus *Acavus*. Few published accounts are extant concerning the quantitative aspects of subsistence strategy; but the general picture is one of non-specialised, broad-spectrum exploitation. There appears to be a tendency for the smaller vertebrates such as porcupines to be more frequently represented than the bigger forms such as bovines. This probably reflects the fact that the smaller animals were easier to hunt than the more formidable one such as the gaur, and that the heavier carcasses were butchered at the kill sites, rather than any deliberate selection for the former by prehistoric man.

As for the exploitation of plant foods, many of the Mesolithic sites in the Wet Zone's lowlands have yielded remains of the wild edible nut termed *kekuna*. At Kitulgala, wild breadfruit, which is rich in starch and fats. has been baked and eaten from the earliest occupations (at well over 12.500 BP) onwards. The wild banana, which grows in the vicinity of Kitulgala, has also been found among the food remains within the cave. The plant material from Batadomba and Kitulgala await detailed analysis, and once this is effected we shall be in a position to form a more complete idea with regard to prehistoric plant exploitation in Sri Lanka. Meanwhile, the present writer has compiled an ethnography of wild food plant utilisation in the island; the dioscorea yams and the palms such as *kitul* and *dotalu* for starch, sugars from fruits such as *palu* and *veera*, and numerous other forms to meet various dietary requirements.

So far, there has been no conclusive evidence that plant or animal domesticates had been exploited in prehistoric times : there is no trace of a Neolithic phase in Lanka. As mentioned earlier, there appears to have been a rather abrupt transition from a Stone Age hunting and gathering subsistence economy to a full-fledged Iron Age technology with irrigated agriculture.

Compared to, for instance, savanna habitats, the rain-forest environment of Sri Lanka has a very low exploitable biomass. This may be worded in an alternate way : the island's carrying capacity is low, as with all equatorial rain-forest environments. Since the estimated environmental fluctuations throughout the Quaternary are not ot any magnitude, it can be hypothesised that prehistoric carrying capacity was never much higher than it is to day. This means that prehistoric human populations would probably not have been much denser or sparser per hectare than the density of hunter-gather tribal populations, namely the Vaddas, in recent times. It is at this juncture that the ethnographic accounts of the Vaddas, written mostly at the turn of the century, assume significance. These indicate that the basic settlement unit was the nuclear family, and that larger groupings were very rare and only seasonal. The prehistoric data at our disposal. meagre though they be, appear to validate the use of this analogy. Most of the open-air sites which may be considered base camps have a modal extent of ca. 50m^2. This has been observed in the coastal sites (the Iranamadu Formation), certain open-air sites in the forests of the West Zone uplands around Handapan-ella, and in the grasslands of the highlands and dry uplands. It is hypothesised that the 50m^2 modal extent represents occupation by not much more than a single nuclear family. The hearths excavated at Kitulgala are also relatively small, averaging some 1m in diameter, suggesting that they could not have serviced more than a nuclear family, thus corroborating the evidence from the open-air base camps as to the number of individuals in an average settlement unit. In this context I might mention that the rubble footing of a structure has been partially excavated at Kitulgala. This feature is coeval with the stratum dated to 12,500 C-14 BP. Once it is completly exposed it would be instructive to compute its square area and then compare it with ethnographic accounts relating to area occupancy by tropical hunter-gatherers.

Seasonal migrations of prehistoric man in Sri Lanka have not been delineated so far with any degree of confidence. However, that such migration did take place can scarcely be be doubted; the Vaddas are said to have followed the game into the hills during the annual wet season in the Dry Zone. But these migrations would probably not have been massive events, in the absence of strong seasonality in the climate; and, besides, large herds of ungulates were probably never extant on the island during the Quaternary, due to the environmental constraint of rain-forest vegetation, thus obviating the need for large-scale human movement in their tracks. The contrary situation is known to have prevailed in the northern tundra, with its vast herds of reindeer on the move being followed by humans.

My explorations in the Horton Plains of the central highlands resulted in the discovery of some 25 Stone Age sites. This ecozone is extremely inhospitable in that it is cold, damp and possesses a low exploitable biomass even by equatorial standards. However, the prehistoric sites were invariably located on strategic points, hill-tops and hill-saddles, in the grasslands which form a prominent feature of these plains. Botanists consider these grasslands to be of secondary origin, resulting from the clearing of the montane rain-forest that constitutes the climax vegetation of this ecozone. Hence it can be hypothesised that prehistoric man had been responsible for the initial clearing of the forest, probably by ring-barking the trees and then setting the dead stands on fire during the February droughts. The resultant grasslands, which would have increased the (? seasonal) habitability of this region and the driving of game by firing the grasslands, once again during the February droughts, is likely to have increased hunting efficiency to the degree of compensating for the low faunal biomass of this ecozone. The same mechanism was probably responsible for the origin of the dry *patana* grasslands of the Dry Zone uplands, particularly in the Uva Basin around Bandarawela. Skeletal remains of a canid from Nilgala cave in the Dry Zone intermediate lowlands and Bellan-bandi Palassa in the dry lowlands bring up the possibility that domestic dogs were used by Mesolithic man for driving game, much as the Vaddas have done in recent times. However, the identification of these canids as domestic dogs, as opposed to jackals, has to be established on a firm footing before this hypothesis can receive serious consideration.

As for interzonal trade or exchange mechanisms, the occurrence of marine molluscan shell fragments in Mesolithic deposits of the hinterland suggests that these were brought in as items of trade. Salt probably constituted a major item of barter. Corroboration of this proposition exists in the discovery of the very small lagoon snail *Potamides cingulatus :* in the lowermost Mesolithic horizon at Kitulgala (over 12,500 C-14 BP). This mollusc is often to be found in the unrefined rock-salt which forms in the coastal tracts of the semi-arid zone over 80 km away ; and its presence at Kitulgala can only be accounted for by postulating its inclusion in salt brought to the site by prehistoric man. Another item of trade appears to have been the tree snail *Acavus* which seems to have been transported to the Dry Zone which is quite outside its natural habitat. This latter form is restricted to the Wet Zone and its occurrence in the Dry Zone in association with a Dry Zone fauna can only be explained as being the result of importation, possibly as currency or ornaments. In fact the specimens found at Bellan-bandi Palassa in the dry lowlands have been identified as belonging to *Acavus roseolabiatus*, which is known to have an extremely restricted habitat range in the wet lowlands encompassing a mere ca. 200 square kilometres of area.

RITUAL AND MORTUARY PRACTICE

Nothing has survived in Sri Lanka by way of prehistoric art. The cave drawings encountered in the lowland dry and intermediate Dry Zones are ascribable to the Vaddas, as indeed has been attested by the Seligmanns, anthropologists who watched the Vaddas execute these primitive semi-symbolic works at the turn of the century. It is significant that none of the subterranean caverns occurring in the limestone terrain of the island bears any traces of ritualistic use. The only item of possible ritualistic import is the discovery of a human frontal bone in the prehistoric deposit of Ravanalla cave. This bone had been bifacially drilled, and the rough sutural edges and a zygomatic prominence chamfered off. One aspect of the bone had been smeared with red ochre. Traces of this latter substance are frequently encountered on prehistoric grindstones; but this is the only instance where one of its uses has been demonstrated.

Apart from fragmentary human remains excavated from the cave sites of Nilgala, Beli-galge, Batadomba, Ravanalla and Beli-lena Maniyangama, remains which were too fragmented for proper analysis, the bulk of the human remains has been secured from the open-air midden of Bellan-bandi Palassa, dated to ca. 6,500 TL BP, where at least twelve individuals have been found represented. The majority of these latter individuals have been assigned to the 25 - 35 year age group, although older and younger speciments do occur. Here, as with all the other Stone Age burials found in Sri Lanka, the bones were excavated from within undifferentiated habitation deposits comprising, notably, ash, charcoal and faunal remains. No obvious burial pits were located by the excavator, although the coarse texture of the matrix would have made their differentiation difficult. The skeletons belong to both sexes, and they occurred in a flexed position with an eastwest orientation. There is some evidence of fractional interment, as suggested by the occurrence of isolated skulls and calvaria in association with somewhat more complete skeletons. Recent excavations at Kitulgala have yielded two fractional interments (among midden deposits) in a stratum dated to ca. 12,500 C-14 BP, and excavations in Batadomba cave produced three humans, one being fractional and the other two more complete, in flexed positions. This latter group from Batadomba has been dated to ca. 16,000 C-14 BP. Once again there are no clear signs of burial pits; rather, the interments appear to have been in slight hollows in the cave floor, and heaped over with food debris. It is very probable that all the burials are secondary, namely after exposure to the elements to divest them of their flesh.

BIOLOGICAL ANTHROPOLOGY

The physical traits of the humans from Bellanbandi Palassa, popularly called Balangoda Man, have been studied by the excavator Dr. P.E.P. Deraniyagala and by Dr. K.A.R. Kennedy of Cornell University. The results of their studies may be summarised as follows. The overall characters may conveniently be described by the blanket term 'Australoid Vaddid' although such taxonomic procedure is no longer in vogue among physical anthropologists. The Australoid traits are considered to be variable. The estimated stature is 174 cm for males and 166 cm for females. The vertebrae, however, are thought to be disproportionately short for the stature, the axis vertebra in the neck in particular. The skull has a variable cranial capacity, and its bones tend to be thick. It is dolichocephalic, with a low vault and a markedly receding forehead. The occipital curvature at the rear is pronounced. The cheek bones are thick and wide. The brow-ridges are heavy at times, and the post-orbital constriction is marked. The nasal bones are concave dorsally and depressed at the root. In some adult males the distance from the lower margin of the nasal aperture to the base of the upper incisors is conspicuously great. The canine fossa is ill-defined and alveolar prognathism is evident in most males. The palate is large. The lower jaw is very robust and tends to possess a pointed chin. The teeth are usually large, especially the molars, although the incisors tend to be small. The pelvis is small. The limb bones are robust.

It is significant that the recently excavated humans from Kitulgala (12,500 BP) and Batadomba (16,000 BP) are said to display traits that are very similar to those from Bellan-bandi Palassa (6,500 BP) despite the considerable difference in time. Professor Kennedy at Cornell has almost completed his report on this material and it is likely to contain very interesting comparisons between these chronologically widely separated populations. Meanwhile, as far as the humans from Bellan bandi Palassa are concerned, Kennedy's analyses employing metrical indices and discrete morphological traits have revealed that traits of Balangoda Man survive in varying degrees among the living populations of Sri Lanka. However, they are said to be most pronounced among the Vadda aborigines, and he affirms that they undoubtedly represent a biological continuum, the latter being the descendants of the former. The links between Balangoda Man and certain tribal populations of India are also said to be strong, although not nearly as pronounced as with the Vaddas. It is worthwhile noting that Sri Lanka's ancient chronicles mention the Vaddas as being the descendants of the aborigines who were on the island at the time of the Aryan intrusion at ca. 500 BC. It is also worth nothing that the Palk Strait separating Sri Lanka and India is only ca. 11m at its deepest. Hence a slight eustatic drop in sea level would create a land bridge between the two countries, and this is likely to have occurred on numerous occasions during the Quaternary, the last being estimated at ca. 7,000 BP. The crossing of the straits by sea craft over the last 30,000 years is also a possibility by analogy with the settling of Australia. It is thus clear that prehistoric human traffic to and fro between India and Sri Lanka would have been commonplace, leading to complex patterns of miscegenation between groups. Moreover, it is also necessary to bear in mind that the southern tip of India would have constituted a cul-de-sec for groups moving down the peninsula under pressures from the northwest and northeast. The present diversity in physical traits among the tribal people of India bear ample testimony to these trends in population movement. It can therefore be concluded that southern India and Sri Lanka constituted a regular melting pot of Stone Age groups, both in terms of their biological traits as well as their cultural concomitants.

HISTORIC PERIOD

The main thrust of this paper has been the prehistory of Sri Lanka. However, it is perhaps expedient to conclude this outline by sketching the sequel to the prehistoric period in Lanka. This will be done in very summary form.

The chronicles maintained by the Buddhist clergy have provided a very accurate chronology for the historic period from ca. 200 BC onwards, when Buddhism was first introduced to the island under the auspices of the Emperor Asoka of India. The period antecedent to this, from ca. 500 to 200 BC, has been termed protohistoric since writing was not extant as yet. However, excavations conducted by me in the ancient citadel at Anuradhapura have revealed that this so-called protohistoric period had an advanced iron technology and irrigated agriculture of rice. It is probable that once radiocarbon dates become available for this horizon the lower limit would be much earlier than 500 BC. (? 1000 BC). Radiocarbon dates secured by Dr. Bennet Bronson of the University of Pennsylvania for the northern site of Kandarodai appear to support this view. Here there are a few dates which have come out as early as ca. 1,000 BC. It is proposed to probe the protohistoric levels of Anuradhapura so as to secure the requisite samples for dating these horizons.

At Anuradhapura, around 200 (? 400) BC there is evidence of a major efflorescence in material culture: there is the introduction of writing, high quality ceramics and glassware and numerous other traits. This conforms with the historical dates for the introduction of Buddhism to the island. The material traits have strong links with the Mauryan culture of northern India, with its epicentre in the imperial court of Asoka. From about 100 BC there are clear indications of links with the eastern Mediterranean: some of the ceramics have been identified by specialists from Prague as being Hellenistic imports. By the first century of the Christian era Roman contacts had been established, as documented by historical sources in Sri Lanka and in Rome, and the Roman trade links appear to have peaked around 300 AD. Thousands of Roman coins assignable to this latter phase have been found in various parts of the island; a recent discovery is a hoard of over 20,000 coins near Godavaya in the south. The final phase of this Roman trade seems to have been around 450 AD, as indicated by coins found in the excavations at the port site of Kuchchaveli in the northeast.

Apart from Roman influences, there are indications of Parthian contacts during this latter period. Certain glazes found on roof tiles of around the fourth century AD appear to have had Parthian origins. This West Asian connection really came into prominence during the seventh, eighth and ninth centuries, as amply demonstrated by the Islamic ceramic finds from the ancient port site of Mantai, which is currently being excavated by the Department of Archaeology in collaboration with the University of Chicago. The West Asian trade at Mantai is superimposed upon by Chinese links from the ninth to the eleventh centuries; and a profusion of imported Chinese ceramics have been unearthed at the site. At other locations, Chinese ceramics from upto the thirteenth century are said to have been found.

So much for international contacts. The Early Historic period (ca. 200 BC-300 AD) witnessed the peak of ancient Sri Lankan culture, and then there were the Middle Historic (ca. 300-800 AD) and Late Historic periods with their own apogees. True urbanism had set in by 200 BC, as exemplified by the ca. 50 ha citadel at Anuradhapura and the very large extents of the towns at Tissamaharama and Kandarodai. High art and monumental architecture, most of it religious, bear ample testimony to the calibre of culture during the Early Historic period, as well as in the two succeeding periods, under the patronage of the kings of Sri Lanka.

The economy of the country was geared to rice cultivation under a highly sophisticated system of irrigation through giant reservoirs and canals. These irrigation works continue to amaze the modern engineers assigned the task of restoring them, or otherwise adapting them to modern conditions. They represent a high point in hydraulic engineering with reference to the entire ancient world. The inception of the systems is likely to have been as early as ca. 450 BC, according to the chronicles.

Finally, there was the decline of the material culture of Sri Lanka from about the thirteenth century onwards. We are not quite certain as to the prime mover in this process; there is one school of thought which attributes at least a part of this debilitation to the spread of malaria, but this has yet to be substantiated. Then came the wars against Portuguese, Dutch and English colonial interests. While ensuring the independence of much of the hinterland of the country,. some five hundred years of these colonial wars left the economy in tatters, untill the final capture of our last capital in Kandy by the English in 1815 through an act of treachery by some of our own notables. From then onwards, the historical process in Sri Lanka assumed a new look, with major influences arriving from the industrial West. These have served to revitalise the economy with its new concepts. However, it is a matter for some pride that our country and culture has not been drowned in this veritable deluge of new ideas, and that beneath the outward veneer of modern "progress" we have managed to keep at least a significant portion of our traditional values, based on the sublime philosophy of Buddhism, the flower of Indian culture.

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A Preliminary Report on the Stone Age of the Union Territory of Delhi and Haryana

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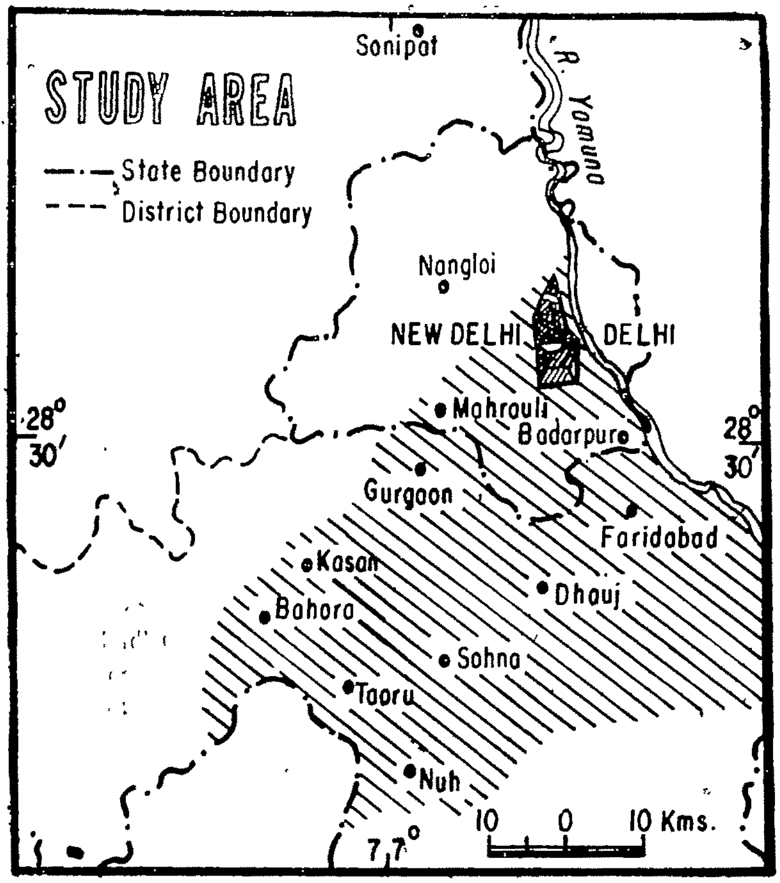
I. THE STUDY AREA

The Aravallis, although subject to much levelling in recent years, are spread like broken waves over Delhi, dipping down to the Yamuna at the Waziribad crossing. In the southern periphery of the city the hills are higher and more rugged in relief. As one proceeds to Suraj Kund in the neighbouring Haryana, past the stone-grinding machines and the dust-laden air of Badarpur, one finds the distribution of the ranges more compact and continuous for at least several kilometres to the south. This hill massif presents a sharp and high southern edge to the plain along the modern Faridabad-Sona road roughly between the Badkhal Lake and the Sona-Paliwal road crossing. Along the Mehrauli-Gurgaon road the topography, particularly to the south of the road, is rocky and broken in patches, and for the sharper contour of the hills one has to go past the Chhatarpur village and the farm-houses of the rich to the Bhatti mines. The patches of broken topography in this sector continue intermittently up to the area of the modern "bypass" to Gurgaon.

From the Delhi belt the Aravallis strike out in two directions, both in conformity with the overall northeast-southwest alignment of the Aravalli system. One strike is towards Alwar, with the hills coming close to the modern road near Sona. Beyond Sona one can climb atop a tableland (the entrance to which is protected by a mediaeval fortification) which continues—always with the hills in horizon—to the vicinity of Tauru. The hills feature sharply between Tauru and Nuh in a section called the Bandhwa Ghati. They also occur in a stretch between Tauru and Manesar on the Delhi-Jaipur road. The second Aravalli strike from Delhi is towards Jaipur. Much of this route traverses the Sahibi valley but the hills are always close by. Of these two routes to Rajasthan the Alwar route with the Asokan edicts of Srinivaspuri (Delhi) and Rupnath (Bairat) on the way was obviously more important in the historical period.

Beyond the urban belt of Delhi the Aravallis constitute a world of comparatively low and rugged hills which are covered mostly by reddish rocks and scrub jungle and contrast sharply with the verdure of the villages and the fields at their feet. The village cattle and goats are generally taken to the top of the hills for grazing, and although wild life is now virtually non-existent one can still startle hares, partridges and peacocks in the scrub jungles. There are also unexpected and beautiful valleys within the range. One such valley which is surrounded on all sides by a low amphitheatre of hills was chosen by Anangapal of the Tomar Rajputs in the 10th century A.D. as his capital, the memory of which now survives only in the village name of Anangapur and the stone masonry dam (at the foot of the hills) associated with his name.



II. The Significance of the Present Study

The credit of discovering the first stone tool in Delhi goes to Surajit Sinha who reported lower palaeoliths on the ridge near the main gate of the Delhi University in a brief note in *Man in India* in 1958, pp 151-153. He collected 4 specimens in all (scraper, handaxe, cleaver and disc) on 8 April 1956 "in front of the ruins of Char Burja mosque." There was a newspaper report on the discovery of lower palaeoliths from the same area in 1983 (?). In the same year B.M. Pande found a tool; a late Acheulian handaxe, "on the roadside in front of the Uttarkhand hostel in the new campus of the University" (the Jawaharlal Nehru University) and reported the find in *Man and Environment* IX, 1985.

The earlier reports are thus only from two areas: the Delhi University ridge and the "roadside" in front of a Jawaharlal Nehru University hostel. Moreover, they deal only with the lower palaeoliths. In contrast the present work has surveyed a large tract in Delhi and Haryana and been able to locate 43 sites, ranging from the lower palaeolithic to the microlithic in character. It is for the first time that it has been possible to outline a Stone Age sequence in this region. What is no doubt equally important is that it has been possible to relate this

Stone Age sequence to a specific stratigraphic situation. One can in all honesty claim that the present work with its discovery of 43 sites in a wide region and the stratigraphic sequence of this Stone Age material has laid the foundations of the Stone Age studies in the Union Territory of Delhi and the state of Haryana.

III. THE INVENTORY OF SITES AND ARTIFACTS

1. *The area between the Kalkaji Temple and the Asokan inscription* (AI) : a casual search in this area revealed only one microlithic point in crystal quartz but one can be reasonably sure that a prolonged and careful search will result in the discovery of more microliths in the area. Even our lone find is interesting because of the light it seems to throw on the background of the growth of the Sakti cult-spot of the Kalkaji Temple and on the general cultural setting of the Asokan inscription.

2. *Lakkarpur* (LKP) : the road to Suraj Kund from Delhi branches off at this point (which is slightly beyond Badarpur towards Suraj Kund) for Faridabad—about 2m thick soil deposit exposed in various places of this area—a microlithic flake occurred *in situ* in this soil. Microliths : parallel-sided blades—6, flakes—3, cores—5, burin—1, point—1, scraper—1. Except a flake which is on a greyish chert all the specimens are in milky to crystal quartz.

3. *S.O.S. Children's Village* (SOS) : the site is to the west of the village which is a little south of the Suraj Kund-Faridabad road—the top of the ridge is considerably disturbed, but the tools apparently came out of the conglomerate exposed here on the surface. Lower Palaeolithic : handaxes —3, scrapers—7, Middle Palaeolithic : points—2, round scraper—1, scraper—1, scraper-cum-borer—1. Upper Palaeolithic : retouched flake—1, retouched blades—2. The material is invariably a brownish fine-grained quartzite.

4. *Anangapur Hills* (ANG) : the road from Suraj Kund to Faridabad passes by the modern Police Post of the village of Anangapur, but the village itself—or at least the major part of it—is more than a kilometre to the south and encircled by a rim of hills pierced only by the road coming from the Police Post side—implements are found sporadically on the surface of the hills but the surface is disturbed because of quarrying. Lower Palaeolithic : flakes—2, scrapers—10, discoid core—1, cleaver—1.

5. *Ankir Pahari* (ANK) : the road from Faridabad to Suraj Kund climbs an extensive low ridge soon after the bifurcation of the road to Badkhal lake—the site is near the beginning of this ridge from the Faridabad side—implements on the disturbed surface. Lower Palaeolithic : discoid core—1 (in brownish quartzite). Microliths : burin—1, point-cum-scraper—1 (both in milky quartz),

6. *Meola Pahari* (MLP) I : the site is about a kilometre south of the Suraj Kund—Faridabad road, between the Anangapur Police Post and Ankir Pahari—Lower Palaeolithic : handaxes —4, scrapers—3, cleavers—5. Middle Palaeolithic : side scraper—1, nose scraper—1, borer-cum-side scraper—1. The material is invariably brownish quartzite including the middle palaeolithic specimens.

7. *Meola Pahari* II : more than 2 km to the south of MLP I—a large natural exposure at the spot showing from the top a thick (1—1.5 m) deposit of soil and a thinner (.5—.75 m) deposit of conglomerate/breccia underlain by bedrock. The lower palaeolithic implements occurred in the conglomerate. Lower Palaeolithic : flakes—2, discoid core—1, core—1, cleavers—3, (one on flake), side scraper—1, keel scraper—1, handaxe—1. Material—brownish quartzite.

8. *Meola Pahari* III : about 1 km to the northwest of MLP II. Lower Palaeolithic : handaxes—2, discoid core—1, scrapers —5. Middle Palaeolithic : cleaver—1 (on flake, edge retouched), scrapers—6, scraper-cum-borer—1. Microliths : borer —1, blade—1. Except the microlithic borer in crystal quartz, the other specimens are in brownish quartzite.

9. *Bhaunkri* I (BNK) : the site is to the north of the road to Sohna from the Badkhal lake area—Lower Palaeolithic (in quartzite) : scrapers—3, handaxe—1, cleaver—1. Upper Palaeolithic (in crystal quartz) : blade core—1, points—4, burin—1, notch—2, retouched cores—6, retouched flakes—16, borer-cum-scraper—1, thumbnail scraper—1, scraper (with a tang)—1.

10. *Bhaunkri* II : about a kilometre to the west of Bhaunkri I. Lower palaeolithic (in quartzite) : handaxes—2, retouched flake—1, side-scraper—1.

11. *Noadah Koh* (NDK) I : the site is to the north of the Badkhal lake-Sohna road, near the village of Noadah Koh. Lower Palaeolithic (in quartzite) : cleaver—1, flake—1.

12. *Noadah Koh* II : the site is about 1 km to the south of the Badkhal lake—Sohna road. Lower Palaeolithic (quartzite) : handaxes—2, scraper—1. Middle Palaeolithic : point-cum-borer—1, scrapers—8 (one in crystal quartz), points—5 (4 in milky quartz), nose scraper (milky quartz)—1. Upper Palaeolithic : blade core—1, blade and blade fragments—15 (11 in crystal or milky quartz), scraper—1 Microlithic : scraper—1, cores—9, lunate—1, p.s. blade—1 (all in crystal quartz). Unless otherwise stated, all specimens are of brownish quartzite.

13. *Paligaon Hills* (PGH) : the site is roughly to the north of the Paligaon village which seems to be an important quarrying centre. Lower Palaeolithic : handaxes—4, retouched flake—1, Middle Palaeolithic : scrapers—7. Microliths : core—1, side scrapers—2, end scraper—1, borer—1. All microliths and a few middle palaeoliths are in milky to crystal quartz.

14. *Mohtabad Hills* (MTB) : the site is further west along the hills—Upper Palaeolithic : blade cores—2, burin-on-core—1, scrapers—3. Microlithic : points—7, cores—2, flakes—2. Except a single piece of microlithic flake which is in quartzite, all these specimens are in crystal quartz.

15. *Gothra* (GTH) : 1.5 km west of MTB—Lower Palaeolithic : scraper—1, handaxe—1, Upper Palaeolithic : blades—5, notch—1. Microlithic : retouched flakes—5.

16. *Dhauj* (DHJ) : 4 km to the west of Gothra. Lower Palaeothic : handaxe—1, scrapers—4, Microlithic : scraper—1.

17. *Sirohi* (SHI) : 2.5 km west of Dhauj. Lower Palaeolithic : scraper—1, discoids—3. Upper Palaeolithic : blade core—1, blade fragment—1, scrapers—2 (all in crystal quartz). Microliths : 25 cores/flakes (crystal quartz).

18. *Khori Jamalpur* (KHJ) : 2 km west of Sirohi. Lower Palaeolithic : handaxe—1 (lanceolate), scrapers—2. Middle Palaeothic : borer—1 (crystal quartz). Upper Palaeolithic : knife—1, blade—1 (crystal quartz). Microlithic : core—1 (crystal quartz).

19. *Tethur* (TTH) : 2 km west of Khori Jamalpur. Upper Palaeolithic : blade cores—2 Microlithic : scraper—1, core—1.

20. *Kherli* (KRL) : 1.5 km west of Kherli. Lower Palaeolithic : scrapers—3, scraper-cum-borer—1 (milky quartz).

21. *Nimour* (NMR) : 2.5 km west of Kherli. Lower Palaeolithic : scraper—1, Middle Palaeolithic : scrapers—3. Upper Palaeolithic : blade core—1, burin—1. Microlithic : point—1, burins—3, scrapers—3, P.S. blades—2, flake—1. All specimens except the LP one are in milky quartz.

22. *Ladho Sarai* (LDH) : on the Mehrauli-Gurgaon road, close to Qutab—upper palaeolithic : blade core—1, cores—2, points—8. Microlithic : borer—1, scraper—1, ps. blades—2.

23. *Chhattarpur* (CHT) : Mehrauli-Gurgaon stretch—Lower Palaeolithic : handaxe—1, scrapers—2. Upper Palaeolithic : blade fragment—1, points—2, scraper—1. Microlithic : core—1, point—1, flakes—3.

24. *Harchandpur* (HCD) : on the way to the Bhatti mines from Chhattarpur—Lower Palaeolithic : scrapers—2, handaxe—1. Middle Palaeolithic : borers—2, points—2. Microlithic : retouched flakes—6, point—1. All except LP specimens are in crystal quartz.

25. *Sikandarpur* (SKN) : Mehrauli-Gurgaon stretch—L.P. : cleaver—1, scraper—1. Upper Palaeolithic : points—6, scraper—1, blade fragments—2, borer—1. Microlithic : flakes—4. All except LP specimens are in crystal quartz.

26. *Nimriwali Pahari* (NMP) : western edge of the hills towards Sohna on the Badkhal lake Sohna road—LP : handaxe—1, MP : retouched cores—2, core—1, scraper—1. UP : knife—1, end scraper on blade—1. Microlithic : scrapers—4.

27. The JNU Hills (JNU) : not far from the main gate of this university campus there is a small market to the western side of the university road. The land outside the university complex slopes away at this point, first to a school and then to a large expanse of undulating rocky land full of scrub jungle and dissected partly by a deep ravine holding rainwater in places. The tools were found around a suitable rocky outcrop in this area. Lower Palaeolithic : handaxes—4, discoid core—1, cleaver—1. scrapers—4. Middle Palaeolithic : borers—4, scrapers—4. Upper Palaeolithic : borers—2, keel scrapers—1.

28. *Bhondsi* (BHD) : on the Gurgaon—Sohna road, to the right. Middle Palaeolithic : scrapers—3 (all in crystal quartz).

29. *Nangri-ki-Dhari* (NGD) : on the Gurgaon—Sohna road, immediately before Sohna, to the right—Lower Palaeolithic : scraper—1. Microlithic (all in crystal quartz) cores—2, scrapers—5, points—3, blades—2.

30. *Bandhawa Ghati I* (BNG I) : the road from Nuh to Tauru crosses a hill range called Bandhwa Ghati. BNG I is in the first stage of this passage on the Nuh side. Lower Palaeolithic : handaxe—1, scraper—1. Middle Palaeolithic : scraper—1, borer (crystal quartz)—1. Microlithic : flakes/crores—5.

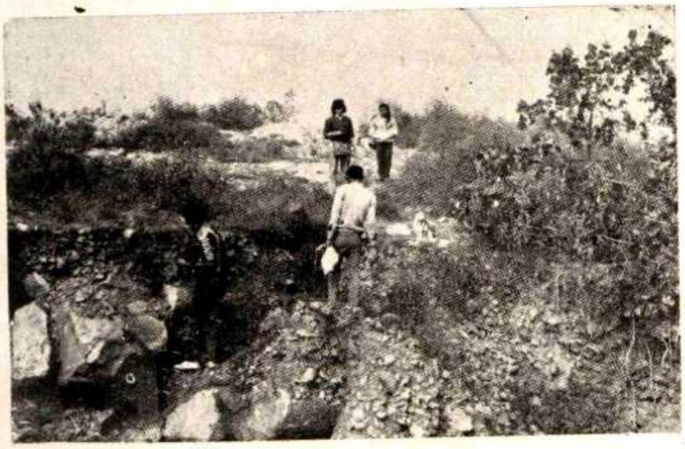
31. *Bandhwa Ghati II* (BNG II) : immediately before the abovementioned passage gets down to the plain on the Tauru side—Lower Palaeolithic : handaxes—4, scrapers—4, Middle Palaeolithic : scraper-cum-borer—1. Microlithic : flake—1.

32. *Dhulawat* (DWT) : on the Tauru-Sohna road, to the left—Lower Palaeolithic : handaxes—2, scrapers—4 (one in crystal quartz), cleavers—3. Microlithic : points—2, scraper—1, burin—1.

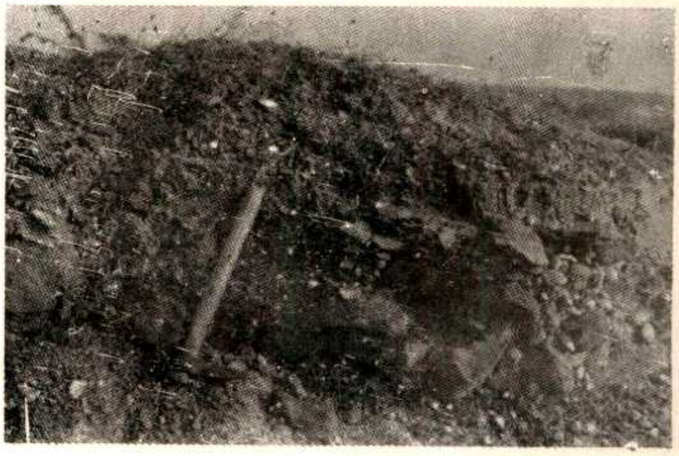
33. *Bhutla* (BTL) : on the Tauru-Sohna road—to the left. Lower Palaeolithic : discoid—1, scraper—1, handaxes—2. Middle Palaeolithic : hollow scraper—1, Upper Palaeolithic : blade core—1. Microlithic : scrapers—2 (in crystal quartz).

34. Bypass to Gurgaon (BTG) : soon after the beginning of the bypass from the Gurgaon side—to the right. Lower Palaeolithic : handaxe—1, Middle Palaeolithic : double-sided-cum-end scraper—1, handaxe—1 (crystal quartz), scrapers—2, core—1.

35. *Manesar* I (MNS I) : on the Delhi—Jaipur road—microliths, all in crystal quartz, embedded in the top soil. Point—1, scraper—2, retouched core—1.

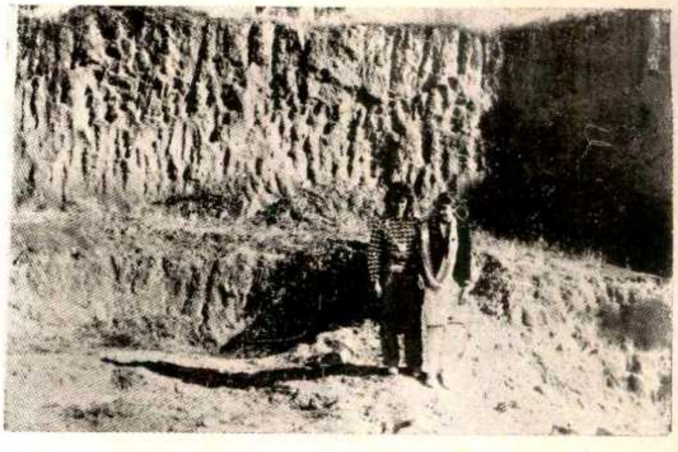


1. The implementiferous conglomerate at Meola Pahari
II. Only lower palaeolithic material has been found here.



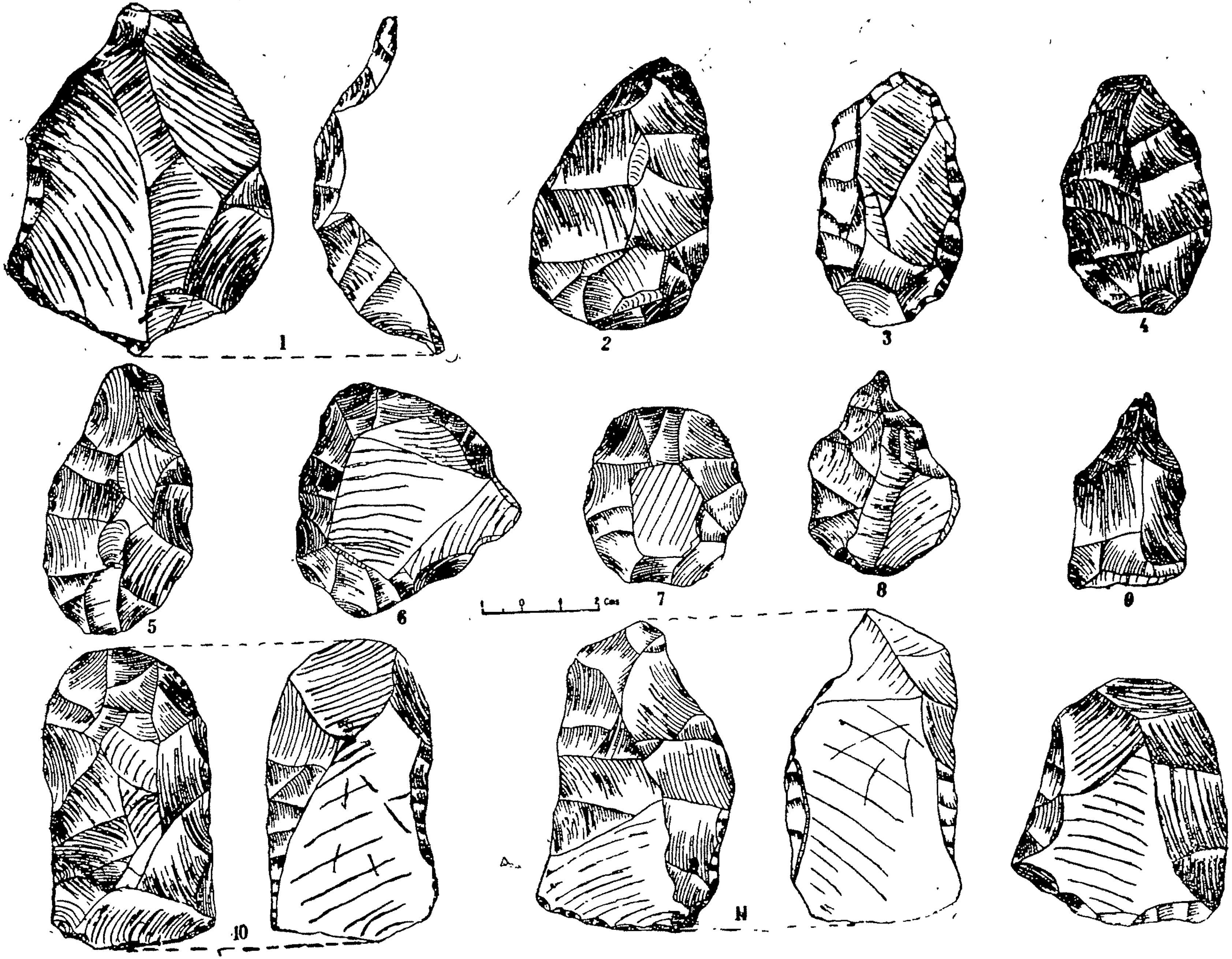
2. The implementiferous conglomerate at Noadah Koh
II. The conglomerate here has yielded both lower and middle Palaeolithic tools.

3. The soil bed with upper palaeolithic material at Bhaunkri I.



4. The thick soil deposit with microlithic flakes embedded at Lakkarpur.

Fig. 1.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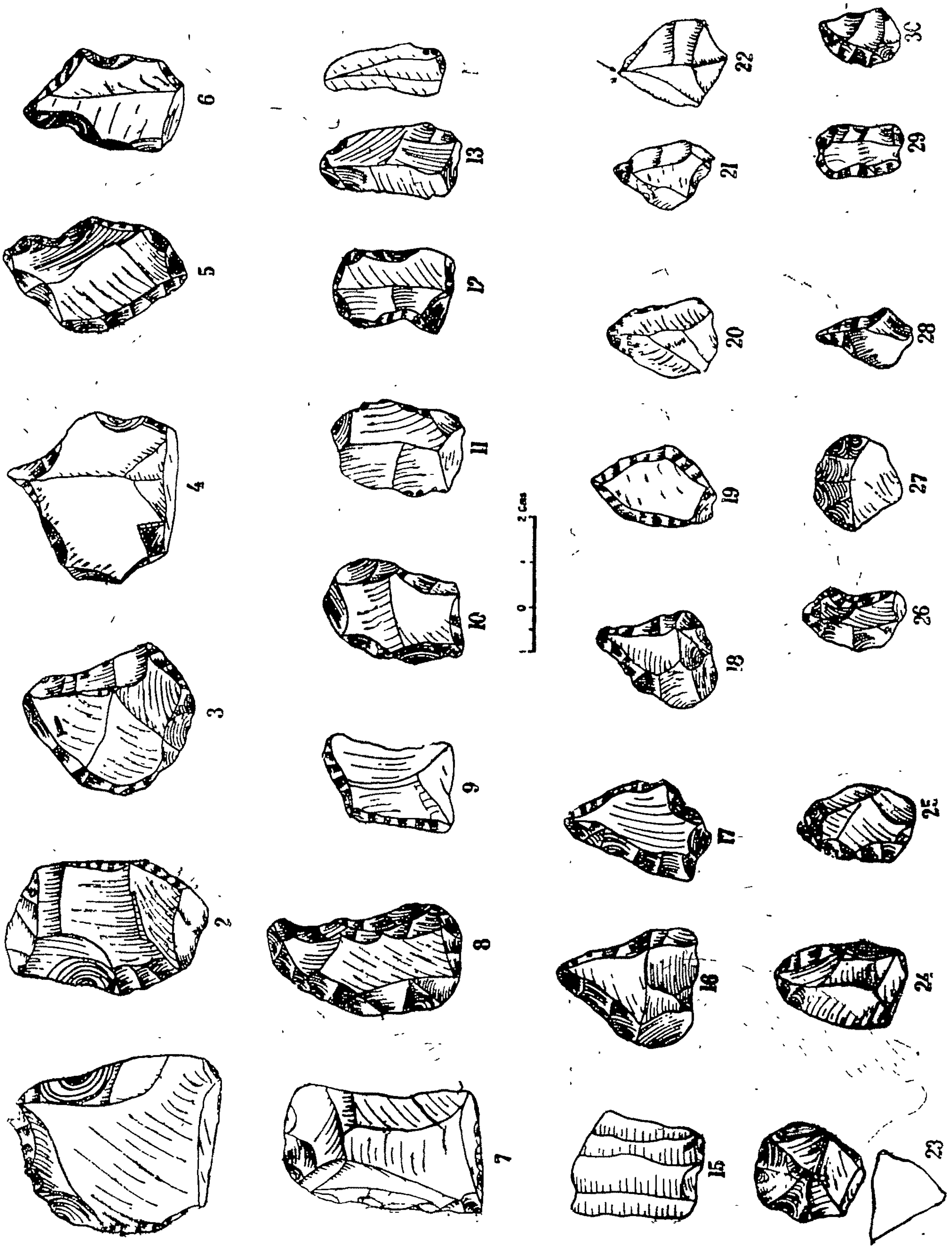

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Fig. 2.

Fig. 1

1. Bhaunkri II—handaxe—180 by 140 by 52 mm—fine-grained quartzite.
2. JNU Hills—handaxe—140 by 90 by 40 mm—fine-grained greyish quartzite.
3. SOS Children's Village—handaxe—130 by 70 by 29 mm—quartzite.
4. Meola Pahari I—handaxe—119 by 74 by 27 mm—quartzite.
5. JNU Hills—handaxe—139 bv 76 by 34 mm—quartzite.
6. Bhaunkri II—side-scraper—110 by 112 by 38 mm—quartzite.
7. Delhi University South Campus—roundscr aper—87 by 75 by 30 mm—quartzite.
8. Bhaunkri II—handaxe—104 by 71 by 38 mm—quartzite.
9. Meola Pahari I—handaxe—99 by 57 by 28 mm—quartzite.
10. Anangapur—cleaver—155 by 83 by 42 mm—quartzite.
11. Meola Pahari I—cleaver—160 by 91 by 42 mm—quartzite.
12. Meola Pahari I—cleaver—128 by 96 by 38 mm—quartzite.

Fig. 2

1. Noadah Koh II—side-scraper—91 by 79 by 24 mm—quartzite.
2. JNU Hills—side-scraper—89 by 62 by 32 mm—quartzite.
3. Noadah Koh II—side-scraper—75 by 59 by 22 mm—quartzite.
4. JNU Hills—borer—75 by 73 by 38 mm—quartzite.
5. Paligaon Hills—side-scraper—79 by 48 by 21 mm—quartzite.
6. JNU Hills—knife—70 mm by 39 by 14 mm—quartzite.
7. SOS Children's Village—blade—92 by 46 by 15 mm—quartzite.
8. Nimriwali Pahari—knife—82 by 42 by 22 mm—milky quartz.
9. Noadah Koh II—knife—56 by 38 by 25 mm—milky quartz.
10. Noadah Koh II—blade—64 by 36 by 17 mm—milky quartz.
11. JNU Hills—retouched blade—56 by 34 by 12 mm—fine-grained greyish stone.
12. Meola Pahari II—blade—59 by 29 by 15 mm—quartz.
13. Harchandpur—blade—60 by 28 by 12 mm—quartz.
14. Noadah Koh II—blade—49 by 15 by 6 mm—fine-grained quartzite.
15. Noadah Koh II—blade core—55 by 45 by 30 mm—whitish stone.
16. Bhaunkri I—point—63 by 52 by 15 mm—milky quartz.
17. Noadah Koh II—point—64 by 39 by 11 mm—milky quartz.
18. Bhaunkri I—point—53 by 38 by 23 mm—quartz.
19. Harchandpur—point—52 by 30 by 10 mm—milky quartz.
20. Bhaunkri I—point—47 by 32 by 8 mm—milky quartz.
21. Bhaunkri I—point—42 by 28 by 10 mm—milky quartz.
22. Bhaunkri I—burin—45 by 31 by 36 mm—quartz.
23. JNU Hills—thumbnail scraper—45 by 31 by 36 mm—quartz.
24. Bhaunkri I—blade—58 by 35 by 17 mm—milky quartz.
25. Bhaunkri I—point—52 by 34 by 12 mm—milky quartz.
26. Bhaunkri I—notch scraper—44 by 25 by 12 mm—milky quartz.
27. Bhaunkri I—end scraper—38 by 39 by 16 mm—quartz.
28. Bhaunkri I—borer—40 by 23 by 12 mm—quartz.
29. Noadah Koh II—side-scraper—36 by 22 by 10 mm—quartz.
30. Noadah Koh II—side-scraper—30 by 25 by 11 mm—quartz.

36. *Manesar II* (MNS II)—about two km beyond MNS I. Middle Palaeolithic : handaxe—1, scraper-cum-borer—1, keel scraper—1. Microlithic : flakes/cores—12.

37. *Manesar III* (MNS III) : beyond MNS II, towards Jaipur—Lower Palaeolithic : handaxes 2, (one in crystal quartz, partly broken)—side scraper—1, round scraper—1, keel scraper—1, (in crystal quartz). Middle Palaeolithic : borer—1, knife—1, cores—2, scrapers—4. Microlithic : scrapers—9, core—1 (all in crystal quartz).

38. *Panchgaon* (PCH) : on the Delhi-Jaipur road—beyond MNS III—Lower Palaeolithic : cleaver—1, discoid—1. Middle Palaeolithic : handaxe—1, retouched flake—1.

39. *Kota Pahari* (KTP) : on the road from the Manesar area to Tauru—a hill range—Lower Palaeolithic : handaxe—2, scrapers —3. Middle Palaeolithic : scraper—1, Upper Palaeolithic : scraper-on-blade—1.

40. *Sarsola I* (SSL I) : one the Tauru-Sohna road—Lower Palaeolithic : handaxes—4, cleavers—3, retouched flake—1, scrapers—2 (one in crystal quartz).

41. *Sarsola II* (SSL II) : Tauru—Sohna road Lower Palaeolithic : handaxe—1, cleavers—4.

42. *Sohna-Ka-Garh* (SKG) : Lower Palaeolithic : cleaver—2, scraper—1, discoid—1.

43. *Delhi University South Campus* (DUSC) : a conglomerate bed is clearly exposed over the bedrock in this area and it was possible to recover, after only a few minutes' search, two lower palaeolithic scrapers (one is a round scraper and the other a side scraper) from this bed.

IV. THE ISSUE OF STRATIGRAPHY

Three stratigraphic units can clearly be isolated. The first is the conglomerate/breccia bed one can clearly study at Meola Pahari II, Noadah Koh II and Delhi University South Campus. At Noadah Koh II we noticed the occurrence of both "lower" and "middle" palaeolithic tools in this bed. Considering the "late" character of our Acheulian artifacts it is not surprising that "lower" and "middle" palaeolithic artifacts should occur together in this context. However, a more careful search may be necessary to settle this point. The second stratigraphic unit is represented by the bed of the upper palaeolithic finds at Bhaunkri II. This bed shows, right below the surface, a slightly blackish soil deposit. The third stratigraphic unit is clearly marked by the microliths embedded in the topsoil of the region. This is apparent at Lakkarpur and Manesar I where such occurrences could be studied *in situ*.

According to our observation lower palaeolithic implements get exposed on the Aravalli surface wherever the relevant conglomerate/breccia bed stands exposed. Except an outcrop-centred occurrence in the JNU hills we do not seem to have found anything which can be interpreted as a lower palaeolithic factory site. Interestingly enough all the sites or occurrences listed by us are from the Aravalli surface which has become considerably eroded in places and forms extensive low uplands in those areas. In other areas the hill top is like a tableland on the surface of which the tools have been found eroded from the original implementiferous deposits.

Technologically the lower palaeolithic industry appears to be a late Acheulian industry. This is indicated by the occurrence of thin and carefully flaked handaxes, well-finished cleavers, etc. The discovery of this Stone Age sequence overlooking the Haryana plain is interesting in the sense that it raises the question of the link, if any, of the upper limit of this succession (i.e., a microlithic horizon) with the beginning of the cultural succession in the adjacent plain.

ACKNOWLEDGEMENT

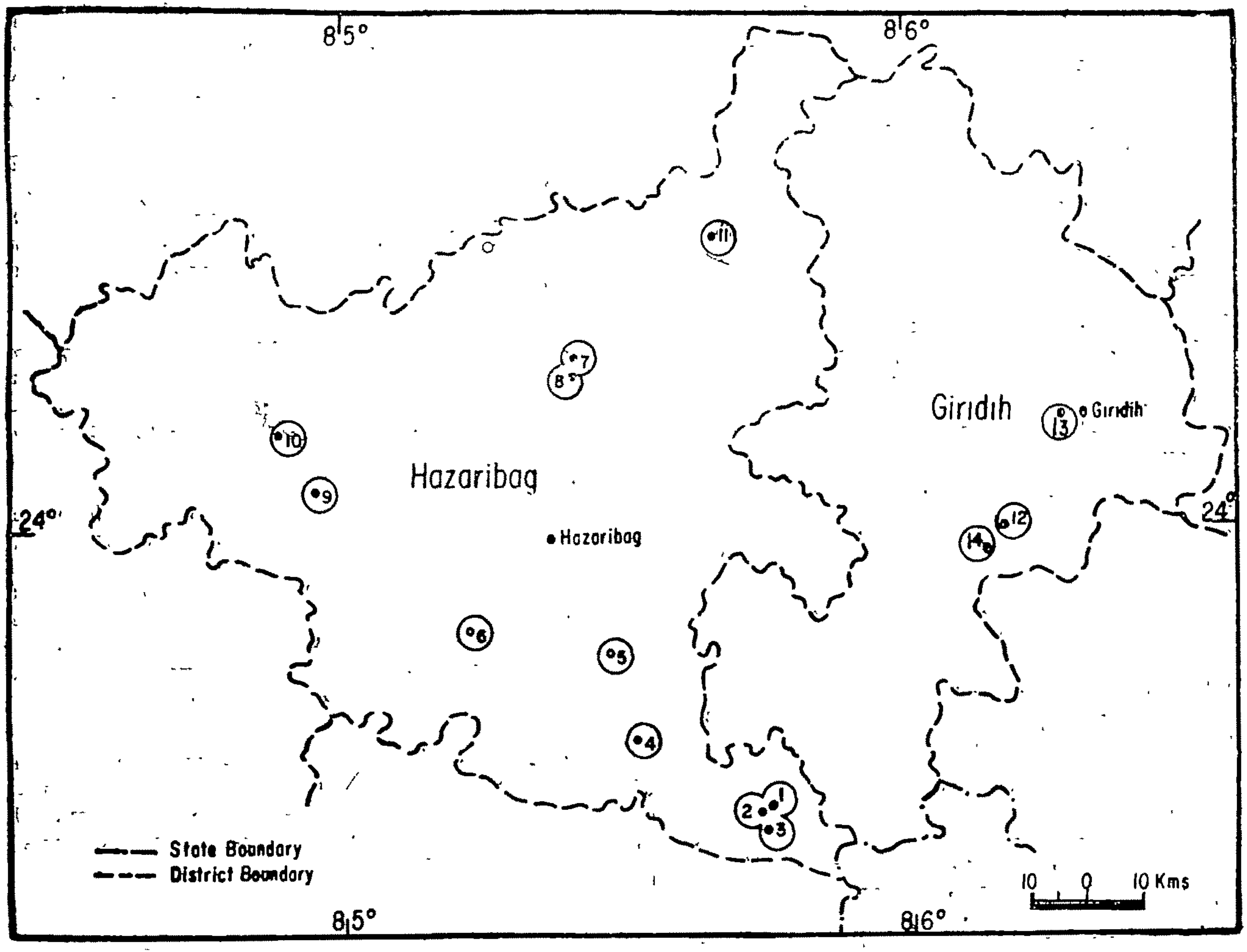
The expenses of this study done in December-January, 1985-86, (about 5000 rupees) have been borne entirely by Shri K.K. Lahiri, a young Advocate of the Supreme Court and the husband of the second author of this article. This may be the first instance of private support on this scale for archaeological fieldresearch in India.

The persons who participated in the fieldwork are Shri R.K. Chattopadhyay who has also contributed the section on the illustrated tools, Shri N.K. Thakur and Ms Kalpana Krishan.

NOTES & NEWS

Notes on the Lithic Industries of the Hazaribagh-Giridih Districts, South Bihar

This survey done in March 1986 was in continuation of our archaeological survey of the Chhotanagpur plateau. Much of these districts is high plateau, sloping perceptibly towards the east (in case of Hazaribagh) and south (in case of Giridih). The high plateau character fringed by hills is apparent in the Ramgarh-Hazaribagh stretch and also in the area west of Hazaribagh. The Giridih region is far more open, although the vicinity of Giridih itself is fringed by one of the most picturesque hill chains of the Chhotanagpur plateau. Towards the south of Giridih the landscape is dominated by the Paresnath peak.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86°
Giridih
Giridih
Hazaribag
Hazaribag
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12
13
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State Boundary
District Boundary
10 0 10 Kms
85°
86°

SITES AND ARTIFACTS

1. *Gola* (GLA): about 5 km from Gola on the Jhalda-Gola road—the general topography is dominated by low undulating ridges and a gravelly surface with wide exposures of a coarse variety of whitish quartz—limited evidence of a flake industry on the surface—core—1; scraper—2, blade—1—total —4 specimens.

2. *Kusumdih* (KSD): about 2 km from Gola on the Gola-Rajrappa temple road—wide, gravelly, sloping land—the succession of bedrock (in places decomposed) and a gritty, lateritic and implementiferous deposit which is considerably eroded and whose surviving thickness is 50 cm—1 m—chopper/chopping tools—8, scrapers—44, flakes—13; retouched flakes —9, borers—4, cores—4, handaxe (on flake)—1, retouched core—1, blade—1, retouched blade—1, points—4—total specimens—90. An amorphous upper palaeolithic (?) industry with a fair percentage of pebble-based tools.

3. *Bansgarha* (BNS): about 4 km from Kusumdih on the Gola-Rajrappa road—the stratigraphy shows bedrock superimposed by lateritic grit—cleaver—1, chopping tool—1, flake, retouched flake—1, scraper—1, blades—2. An amorphous *upper palaeolithic* industy.

4. *Hisagarha* (HSG): about 6 km from Ramgarh on the Ramgarh-Hazaribagh road—lateritic gritty surface with crystal quartz chunks—a flake industry: scrapers—4, retouched flake —1 —total specimens 5.

5. *Mandu* (MND): a few km from Hisagarha towards Hazaribagh on the Ramgarh-Hazaribagh road—in the section one notes about 50 cm thick conglomerate formed by pieces of quartz—crystal quartz used for artifact—*Upper palaeolithic*: blade core—1, blade/flake—1, flake—1, point—1—total specimens—5.

6. *Barkagaon* (BKG): there is a road from Hazaribagh to Simaria via Barkagaon and Tandwa. The road is deeply forested for a major stretch before Barkagaon. Before one comes down from the hills on the Hazaribagh side and approaches the outskirts of the large village of Barkagaon there is an extensive stretch of eroded land to the right side of the road. The section shows a succession of (1) bedrock, (2) sandy and yellowish mottled clay and (3) red soil deposit interspersed with grit and nodules. This red soil deposit is implementiferous.

   It has not been possible to establish any subdivision of this implementiferous red soil deposit on the basis of the types of implements. *Lower palaeolithic* : scrapers 6, retouched flake—1, flakes—3, handaxes—2. *Middle palaeolithic* : scrapers—4, flakes—4, borer—1, handaxe—1. *Upper palaeolithic*: blade core 1, blade/blade fragments—3, scraper-on-blade—1. —Total artifacts 27 (LP—12, MP—10, UP —5).

7. *Karso* (KSO): about 4 km from Barhee on the Hazaribagh-Barhee road—the upper soil deposit is eroded exposing extensive outcrops of quartz—the artifacts, although infrequent, are found on this exposed surface. *Lower palaeolithic* : handaxe—1, scrapers—2. *Upper palaeolithic* : point—1, blade fragment—1, retouched blades—3, scrapers—2, borer—1—total artifacts—11 (LP—3, UP—8).

8. *Bonga* (BNG) : 9 km from Hazaribagh on the Hazaribagh-Barhee road—a large tract of eroded land with outcrops of quartz—the artifacts occur in association with these outcrops. *Lower palaeolithic*: handaxe—1, discoid 1, *Middle palaeolithic*: retouched core—1, retouched flakes—3, points—3, thumbnail scraper—1. *Upper palaeolithic*: blades—2, flakes—2, blade—1—total artifacts—16 (LP—3, MP—8, UP—5).

9. Pundra (PND) : about 3.5 km from Simaria on the Hazaribagh-Tutilawa-Simaria road—surface with exposed outcrops of quartz—artifacts found associated with these outcrops. *Lower palaeolithic*: handaxe—1, scraper—1. *Upper palaeolithic*: scrapers—5, flake—1, retouched flakes—3, retouched blades—3, point—1—total artifacts—15 (LP—2, UP—13).

10. *Paradih* (PRD): about 6 km from Chatra towards Simaria via Bagra—surface with quartz outcrops exposed. *Lower palaeolithic* : handaxes (broken)—2. *Middle palaeolithic* : levallois flake—1. *Upper palaeolithic*: retouched blade—1, retouched core—1, backed knife—1, retouched flake—1, flake—1.

11. *Neropahar* (NPR): about 5 km from Domchanch between Kodarma and Domchanch. Surface with quartz outcrops exposed. *Lower palaeolithic*: scraper—1. *Middle palaeolithic*: point—1. *Microlithic*: scrapers—2, flake—1, point—1, retouched blade—1.

12. *Baragunda* (BGD): the place is towards Dumri from Giridih. Before one reaches Dumri on the Grand Trunk road one takes a turn towards Baragunda from Dhawatahr. Extensive mining deposits slope down to a *nullah*. The assemblage comes from the *nullah* section and represents apparently an amorphous assemblage. *Upper palaeolithic* element: points—3, blades—3, core exhausts—2, burins—2. Miscellaneous elements including a polished ring stone.

13. *Pachamba* (PCM): close to Giridih—the material comes out of the eroded red soil lying on a quartz-strewn surface. *Upper palaeolithic* (?): chunks of raw material—2, flakes—6, retouched flakes—2, scrapers—2, borer—1, points—3, blades —3, burins—2.

14. *Paresnath Hillslope* (PSN): eroded gullies close to the area of madhuban. *Upper palaeolithic*: core—1, retouched flakes —1, blades—3, burin—1, thumbnail scraper—1.

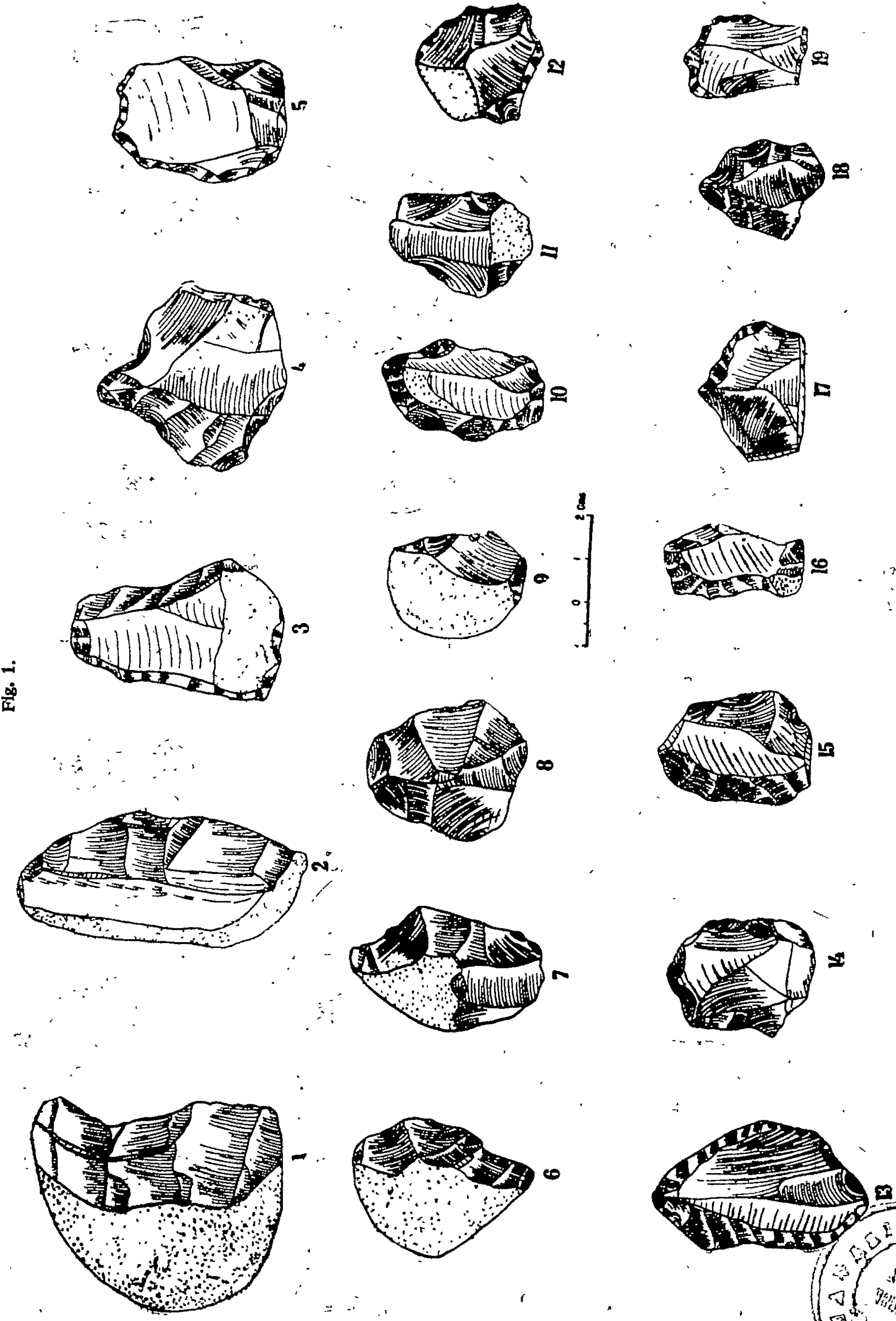
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Fig. 1.

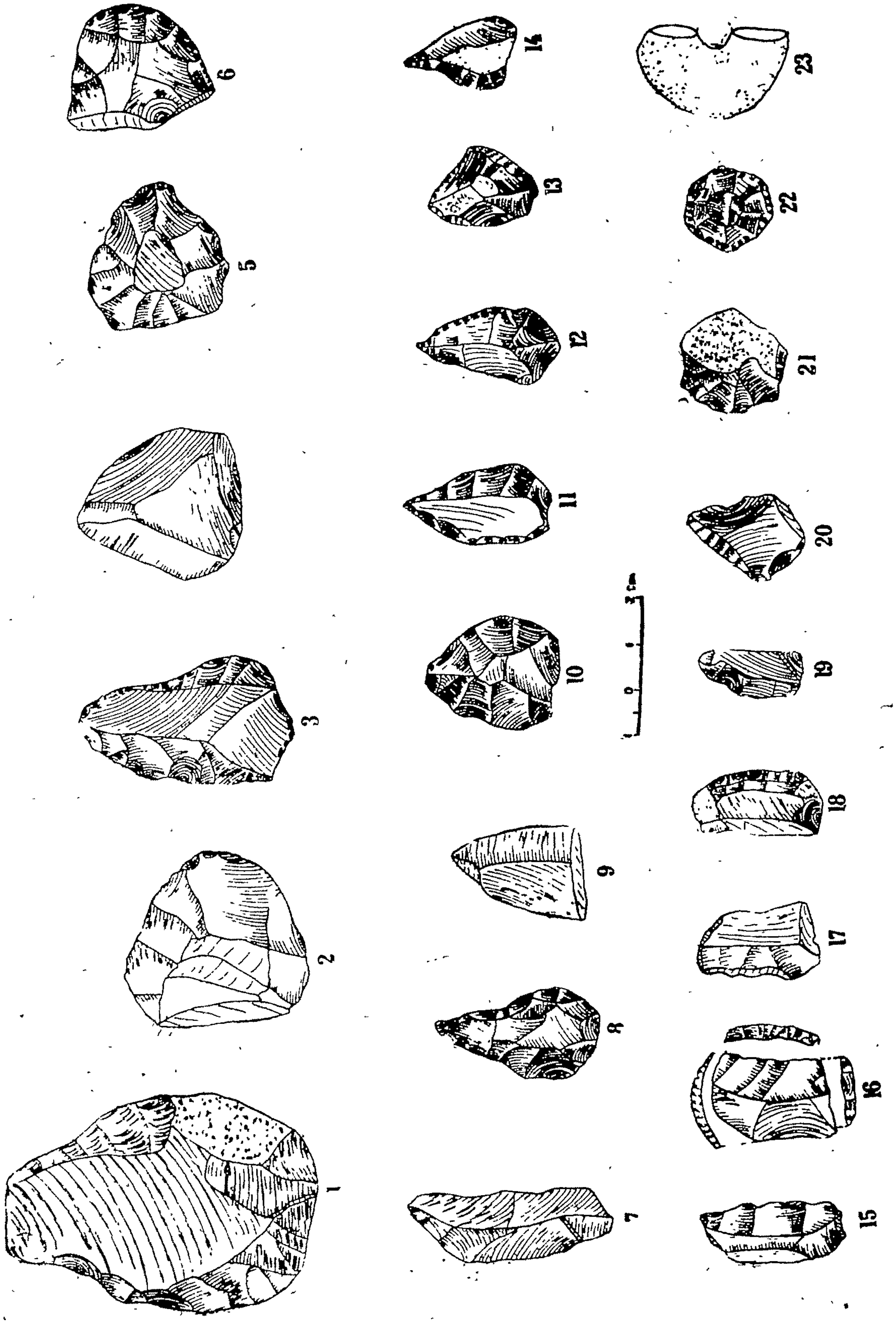
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Fig. 2.

BRIEF DISCUSSION

Broadly, the implements occur in this area in three contexts: lateritic grit, red soil deposit and around quartz outcrops. The first two contexts do not show any stratigraphic division, but the lower palaeolithic—upper palaeolithic spectrum of the lithic industries is clear enough. The lower palaeolithic material suggests advanced Acheulian, and one wonders if these assemblages, despite the presence of lower, middle and upper palaeolithic tool types, cannot belong to a generally amorphous pattern and constitute an upper palaeolithic horizon in this region. The occurrences around the quartz outcrops apparently belong to a separate category and there the distinction between the lower palaeolithic and the middle-upper palaeolithic horizons is genuine enough.

ACKNOWLEDGEMENT

We are indebted to Shri S. Sinha-Sardar, the Divisional Forest Officer, Hazaribagh and Shri Banerjee of his office for their help. The illustrations accompanying this note have been made possible by a small grant from Smt Nayanjot Lahiri and Shri K.K. Lahiri.

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Fig. 1

1. Kusumdih—chopping tool—114 by 100 by 47 mm—quartzite. pebble.
2. Kusumdih—chopping tool—130 by 61 by 55 mm—quartzit pebble.
3. Kusumdih—side-scraper—95 by 62 by 19 mm—quartzite.
4. Kusumdih—borer—85 by 77 by 24 mm—quartzite.
5. Kusumdih—side-scraper—79 by 54 by 18 mm—milky quartzite.
6. Kusumdih—chopping tool—81 by 63 by 38 mm—quartzite.
7. Kusumdih—side-scraper—86 by 62 by 56 mm—quartzite.
8. Kusumdih—round scraper—69 by 60 by 43 mm—quartzite.
9. Kusumdih—side-scraper—59 by 45 by 23 mm—quartzite.
10. Kusumdih—side-scraper—72 by 44 by 18 mm—quartzite.
11. Kusumdih—flake/blade—65 by 45 by 15.mm—quartzite.
12. Kusumdih—side-scraper—63 by 50 by 17 mm—quartzite.
13. Kusumdih—side-scraper—102 by 54 by 23 mm—quartzite.
14. Kusumdih—side-scraper—65 by 48 by 27 mm—quartzite.
15. Kusumdih—side-scraper—69 by 52 by 24 mm—quartzite.
16. Kusumdih—side-scraper—65 by 30 by 17 mm—quartzite.
17. Kusumdih—borer—61 by 43 by 15 mm—quartzite.
18. Kusumdih—point—59 by 45 by 13 mm—milky quartz.
19. Kusumdih—retouched blade—56 by 34 by 12 mm—quartzite,

Fig. 2

1. Pundra—handaxe—135 by 94 by 44 mm—quartzite.
2. Baragunda—bifacial scraper—75 by 74 by 33 mm—quartzite.
3. Pundra—side-scraper—92 by 52 by 29 mm—quartzite.
4. Paradih—plain levallois flake—70 by 62 by 22 mm × quartzite
5. Baragunda—side-scraper—63 by 58 by 36 mm—quartzite.
6. Paradih—side-scraper—47 by 63 by 22 mm—quartzite.
7. Paresnath Hills—blade—88 by 28 by 8 mm—a cherty material.
8. Karso—point—70 by 39 by 19 mm—quartzite.
9. Baragunda—levallois flake—58 by 38 by 17 mm—quartzite.
10. Bonga—point—59 by 48 by 18 mm—quartzite.
11. Karso—point—62 by 32 by 21 mm—quartz.
12. Bonga—point—61 by 36 by 23 mm—quartz.
13. Pachamba—point—49 by 29 by 17 mm—quartzite.
14. Pachamba—borer—47 by 33 by 15 mm—quartzite.
15. Karso—blade—60 by 26 by 10 mm—milky quartz.
16. Karso—retouched blade—54 by 35 by 12 mm—milky quartz.
17. Karso—blade—51 by 35 by 13 mm—milky quartz.
18. Pundra—side-scraper—55 by 26 by 17 mm—quartzite.
19. Pundra—notched scraper—45 by 17 by 13 mm—milky quartz.
20. Pundra—point—51 by 38 by 13 mm—milky quartz.
21. Bonga—thumbnail scraper—43 by 38 by 28 mm—milky quartz.
22. Paradih—retouched core—40 by 34 by 18 mm—milky quartz.
23. Baragunda—ringstone—broken slatestone.

The Sedimentological Basis of the Mohenjo-daro Flood Hypothesis—A Further Comment

At last, Dales and Raikes have contributed sedimentological data and arguments in support of their conjectures, so my (Wasson, 1984) rekindling of the Mohenjo-daro flood hypothesis has had a positive result. There is probably little to be gained by continuing the debate in this manner for, without further stratigraphic and geomorphic investigations of the site and the Indus sediments, there is nothing new to be said. What is most urgently needed is a test of the flood hypothesis.

I am tempted to terminate my reply at this point but the mildly offensive way in which Dales and Raikes have responded to my remarks throws into strong relief some of their more dubious comments, and so their reposte requires further discussion. Dales, in his introduction, is frustrated by the debate's reversion in my hands to subjects such as grain size rather than focusing on the social, economic and cultural impact of the putative flooding phenomenon. In an earlier paragraph Dales admits that the total evidence was incompletely used in previous writings by himself and Raikes. The latter noted that the sedimentary study was carried out for archaeologists who, we are told with a contemptuous air, are not likely to wish to know the details of grain size analyses. In the same paragraph Raikes asks that a hydrologist should be expected not to omit considerations of grain size.

What sort of methodology are we confronted by in this set of remarks ? We are expected to accept on face value the conclusions of an 'expert' without benefit of seeing the data from which the opinions are derived. Raikes is clearly more impressed by the competence of the users of data relating to modern accummulation rates rather then the veracity of the data itself. We are expected to meekly accept the conclusions about the flood hypothesis so that the social etc consequences can be the focus of future studies, despite the observation that the total evidence has been incompletely used. This is asking too much, even of the dimwitted archaeologists who seem to inhabit Raikes' scholarly world. If a hypothesis is never to be questioned then it is worthless and to argue otherwise is to retreat to faith, not science.

Of course there are bigger issues than grain size and floods but if Dales wishes to be taken seriously in this debate then he must accept that each element of his ideas will be tested and evaluated. If he wishes the social etc consequences of flooding to be a major research thrust then he is obliged to demonstrate that major floods occured. We cannot investigate the effects of a phenomenon which has not been adequately shown to exist. There is a strong odour of self-righteous indignation about so much of this 'reposte', leading me to conclude that the normal rigour of scientific tests is far from the minds of Dales and Raikes.

What of the future ? As a geomorphologist and not an archaeologist, I would like to see a comprehensive study of the Quaternary history of the Indus alluvium in so for so it is relevant to the rise and fall of Mohenjo-daro, I accept that the sedimentation rate at Mohenjo-daro. was very high during the city's occupation but was it anomalously high relative to the rate preceding the construction of the city ? I am still to be convinced about the accuracy of modern rate estimates. Raikes displays his total ignorance of micro-palaeontological techniques in Quaternary studies by suggesting that rapid and continuous sedimentation are inimical to their successful application. It is precisely these techniques along with detailed sedimentological analyses of thin sections of laminae that will provide a test of the flood versus lake hypotheses. Dales and Raikes began their work at Mohenjo-daro in the 1960's and palaeoenvironmental techniques have improved enormously over the last two decades.

In conclusion, the progress that has been made by archaeologists in the study of the Harappan civilization needs to be supplemented by a much more rigorous palaeoenvironmental analysis of the north-western part of the Indo-Pakistan sub-continent. Flooding at Mohenjo-daro, stream diversion or estuarine infilling at Lothal, the ravages of tectonic and climatic disturbance of the sub-Himalayan drainage network, and changes of avilable moisture during the last 10,000 years all must be woven into the archaeological fabric. Only then will the importance of any particular part of the puzzle be realized,

REFERENCE

Wasson, R.J., 1984. The Sedimentological basis of the Mohenjo-daro Flood Hypothesis. Man and Environment 8 : 88-90.

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Report of the Indo-French Archaeological Mission : Summary of the 1985 Field Season

GEOARCHAEOLOGY (M. C. Courty)

The geoarchaeological survey was based, as in 1983 and 1984, on the stratigraphic study of tube wells 8 to 12 meters deep. The soil study rests upon a series of 1.50 meter deep probes dug on the outskirts of several protohistoric sites, all located in Haryana :

- —site 230 (south of Dhanana, map 53 D1) ; the plain is partly covered with sand dunes,
- —site 255 (Bhurtana, map 44 P 13), dune zone,
- —site 278 (south-west Mangali, 44 O 12), alluvial plain,
- —site 288 (north-east Mangali, 44 O 12), alluvial plain,
- —site 114 (north-east Jhansal, 44 O 8), loamy-sandy plain.

In very rare cases, we have been able to study already existing sections :

- —site 289 (Mirka, 44 O 16), dune,
- —site 175 (Bhadra, 44 O 4), inter-dune depression,
- —site 290 (Bhadra, 44 O 4), inter-dune depression,
- —point 61 (south Siswal, 44 O 12), dune.

These probes show that the sites are all posterior to any important phase of alluvial deposits and that no important natural deposit has taken place in the area since protohistoric times except for a few zones of depressions and certain movements of active dunes. Samples have been taken for thermoluminescence and C 14 datation.

On 4 of these sites (230, 288, 175 and 290) ancient irrigation canals are present. The filling up of these canals, the identified materials of clearing and the soils buried underneath the materials of clearing have been carefully studied with a view to determining the way these canals worked, and the origin of the carried and deposited materials.

As a result of the 1985 field season, we can now assert that no river flowed south of Hansi during protohistoric times. In this area, the first alluvial deposits are 8 meters deep ; they are inter-stratified with dune levels. The most recent alluvial deposit is therefore posterior to the setting of the dunes. The next 6 meters alternate aeolian levels and flood deposits. Gradually the landscape got levelled. The two upper loamy sandy meters are the result of the removal of the flood deposits by the wind action and a mixing up of it with the preexisting sandy sediments. This aeolian activity is contemporary with the protohistorical period and also posterior to it since in the probes located on the outskirts of the protohistoric sites, the archaeological material is scattered over the 30 upper centimeters.

West of Hissar (Siswal-Jhansal) the observations in the wells and the probes confirm the hypotheses proposed after the seasons 1983 and 1984. No trace of intense alluvial deposit is noticed in the 6 superior meters. Therefore, as in the zone south of Hansi the phases of alluvial activity are very much anterior to the first settlements. The protohistoric settlements lay on the loamy sandy plain already wind-eroded. It is only west of Hissar, that we can identify a real rivercourse which should probably correspond to the Chautang.

West and east of Bhadra the irrigation canals are dug into an inter-dune depression. The deep burial of these canals and the sheer thickness of the filling material are a witness to the problems of constant sanding up which the protohistoric agriculturists probably had to face. The soils of this inter-dune depression have also been cultivated.

ARCHAEOLOGY (H.P. FRANCFORT)

During the 1985 season, 61 archaeological sites have been visited. The area surveyed extends from Bhadra to Hansi, south of the road Hisar-Hansi.

Most of the sites are from the so-called medieval period (8—18 e centuries). However, some of these are protohistoric and which we can add to the ones already known. Eight of the latter date from early Harappan up to late Harappan period. Only two are mature Harappan. Six sites provide PGW and NBP material. These are located east of the area surveyed. Kushan and Gupta sites are also present. We report also an unrecorded material—end bronze age, beginning iron age—which displays painted pedestal vases and black and red polished ceramic among which is one carinated bowl which looks very much like the first millenium ceramics of the Iranian Plateau.

The settlements of medieval times are spread out over the whole area, whereas those of the historical periods (Maurya, Sunga, Kushan, Gupta), are restricted to the plains and the irrigable zones.

During protohistoric times, the picture of a settlement in plains and irrigable zones is even sharper. This contradicts the old thesis of a settlement limited to the banks of the rivercourses.

The protohistory of this area presents another distinctive feature : the pre-eminence of the early Harappan settlement over the mature Harappan. We are now able to assert that the main agricultural development of the area comprised between the Sutlej and the Yamuna has taken place during the early Harappan period. Here, the mature Harappan is a secondary phenomenon the origin of which is exogenous. This hypothesis remains valid whatever the fluctuations in the datations of the early and mature Harappan periods, and whatever the alleged place of origin, the Indus valley.

At the end of the bronze age and during the iron age, the shrinkage of the settlement is confirmed. The area starts again to be inhabited on a large scale in the Kushan period. This continues till the present with, perhaps, a partial interruption at the beginning of medieval period.

ETHNOARCHAEOLOGY (V. ROUX)

The first study focused on the quantitative evaluations of protohistoric ceramic production and on the relevance of observation data upon which the evaluations are usually founded in archaeology.

These observation data are : number of kilns, volume of ceramic residues, density of sherds per square meter, surface area of the craft activity area. Their relevence has been checked out in 7 villages where we studied first the relationship between the number of klins, the number of potters and the number of annual firings per year and per potter. Then we concentrated on the relationships between the volume of ceramic residues and the rate of production in some 15 firing ditches. Lastly, we studied the cognitive value of the surface area of the craft activity area to infer a rate of production. In conclusion, it appeared that none of the observation data were relevant for evaluating ceramic production due to its multivarious nature (for example, the volume and the density of the ceramic residues do not vary only with respect to the rate of production but also according to the rate of breakage during firing, different ways of covering the klin, the re-use of ceramic residues as back-fill, localization of refuse areas). It is only by comparing production from site to site in the same region, or production from one period to another on the same site, that evaluation becomes possible.

The second part of our study was to examine the problem of craft specialisation from a technological point of view, since the previous ethnoarchaeological investigations had pointed out how difficult it was to approach it from a topographic or temporal point of view (disposal of the craft areas, time spent on production).

Our investigations took place in six different villages and focused on the different techniques used nowadays, the different pots produced, the quality of the production and the time spent on learning the techniques.

It would now appear that a detailed study of learning how to throw a pot on a wheel is definitely a way to approaching the problem of craft specialisation. This is the technique, unlike the handmade techniques, which demands the most time to be mastered and, because of that, cannot be learnt by every domestic group of a society.

Moreover, this study of training in making pottery should give us clues to the concept of standardization.

Book-Reviews

Studies in the Archaeology of India and Pakistan, editor Jerome Jacobson, Oxford and IBH Publishing Co. New Delhi. American Institute of Indian Studies, New Delhi, 1986. Price not stated.

This collection of twelve essays, all by American scholars and published under the careful and elegant editorship of Jerome Jacobson, is one of the better publications in our subject in recent years. The relationship, if any, between central and southern Asia during the middle pleistocene is the theme of opening enquiry by R.S. Davis who puts more emphasis on the relevant environment-oriented studies than on a pure culture-historical approach. J. Desmond Clark and Martin J Williams present a preliminary report on the palaeoenvironments and prehistory in the upper Son valley. This is a succinct statement with a lot of multidisciplinary investigations in the background. R.H. Meadow's review of the pattern of faunal exploitation in the Greater Indus valley provides, similarly, an important data-base. Louis Flam's examination of the prehistoric settlement pattern in Sind between 4000 and 2000 B.C. in the light of palaeogeography is based on a detailed fieldwork but not many of us would share his belief in the idea of "outer Elam". James H Cleland's study of the lithics and cultural process in the Indus region has led him to formulate 5 propositions, all of which are rather fundamental, indicating as they do a steady element of continuity and diversification. The article by G.F. Dales on the various dimensions of his Bala Kot project makes exciting reading and should underline the present author's contention that without a constant and close-knit interaction between archaeology and the natural sciences, archaeology does not have any future as an academic subject in India. Jerome Jacobson's theoretical analysis of the possible dimensions of the Harappan civilization as an early state will merit careful reading and thought. W.A. Fairservis reviews the "archaeological evidence in connection with the identity of the language of the Harappan script". Much of this entirely subjective. J.G. Shaffer's analysis of the protohistoric cultural development is one of the very few clear expositions of the protohistoric situation in this area. One suspects that the case for millet as a kind of revolutionary crop in the late Harappan context has been pushed a bit too far in Gregory Possehl's analysis of "African millets in south Asian prehistory". J N Pal reports millets from Koldihawa in the present issue of this journal. Most of the writings of K.A.R. Kennedy are connoisseur's delight, and his article on Adittanallur in the present volume is no exception. The first rouletted ware has been put by Vimla Begley in her study of the early historic archaeology of south India as early as the second century B.C. On the whole this is a nicely brought out collection of a number of well-written (and in some cases exciting) essays.

Dilip K Chakrabarti

Archaeology of Southern Uttar Pradesh, Ceramic Industries of Northern Vindhyas, by J.N. Pal, Swabha Prakashan, Allahabad, 1986. Price Rs. 250/-

We are indebted to Allahabad University for bringing out a rich sequence of prehistoric cultures in the Ganga, Belan and Son valleys, and in the present volume Dr. J.N. Pal, an important member of the Allahabad team, describes the relevant ceramic industries from the associated Vinnhyan areas. The volume is characterized by careful documentation and will serve as a reference mannual for the region. Dr. Pal ascribes a 3rd-2nd millennium B.C. date for the Vindhyan neolithic. This is in contrast with the opinion expressed in his article in the present issue where he finds the three early dates from Koldihawa "dependable". Much of his material was previously unpublished. From this point of view also this is a welcome volume.

Dilip K Chakrabarti

Recent Advances in Indo-Pacific Prehistory, editors, V.N. Misra/Peter Bellwood, Delhi 1985: Oxford and IBH Publishing Co. Price not stated.

Although published as late as 1985, these proceedings of the international symposium on Indo-Pacific prehistory, held in December 1978 in Pune, contain a large amount of still very useful material. A detailed review is not permitted by the constraints of space but two points lend distinction to this volume: (1) the substantial quantity of data and the theoretical neatness with which most of these data have been handled, and (2) the thoroughness of the editing which may well be the envy of many of us. Its 70 articles are spread in four sections: the Acheulian and its context in south Asia, "microlithic industries: a common origin? tools of hunters?", the first farmers in monsoon lands" (in botanical, ethnographic, regional and zoological perspectives) and "megalithism in India."

Dilip K Chakrabarti

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